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End-of-degree Thesis

Aerospace Engineering

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Water and Energy Management in Bamba Children's home (Kenya)

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Abstract

In this final degree project a study on the water and energy availability and management in Kabarnet town in Kenya is going to be performed.

In order to do so, statistical, mathematical and in general, engineering methods are going to be used in order to examine the feasibility of covering totally or partially basic needs of their population. Furthermore, several approaches will be made on the matter, taking into account rain data from 1985 until 2017, electricity coverage, waste water management... Starting from the rain data, and using matlab, a tool will be developed. Based on Monte Carlo statistical method, its role will be to randomize the amount of rain water for future years taking into account previous years data with Euler Maruyama integration. This tool will have several practical uses, limits are in the reader's imagination. An example is: sustainable water and energy consumption policy that, according with the developed code will assure their needs to be covered in a certain range of time with an specified percentage of probability. Another example would be, in the agricultural sector, obtaining the optimum time of the year for growing certain types of vegetables, cereals... as Kenya's economy is mainly based on agricultural products.

Moreover, important issues as social, political and economical frameworks will be considered. Finally, budget and financing for the project will be proposed and studied.

The main goal of this project is to become real at some stage in the next two of years. Therefore feasibility is a key point which means being realistic with the available resources regarding financing, labour costs, materials...

The mathematical tool developed can be used for any other country or region in order to predict amounts of rain and calculate water storage levels depending on expenses. Although, for this case, consumption is particularized for the case of Bamba Childen's Home, which is an Orphanage in the city.

As a first stage, the project was going to analyze and introduce solutions to this problem on a bigger scope as it is the whole town of Kabarnet, although, due to complexity and lack of data, it will be constrained to Bamba, which that takes care of up to 35 kids of from 0 to 18 years old.

Concluding, the author's final degree thesis will be devoted to facilitate access and management of available resources of the orphanage, using knowledge and tools provided by the university to cover basic and primary needs of the children and workers of Bamba.

Keywords: Water management; statistical study; numerical methods; energy management; Kenya; Development Cooperation; water recycling.

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Special dedication to my family and all Bamba kids.

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Personal motivations and objectives

In the summer of 2017, I decided for the first time of my life to do a trip abroad to Africa. The final choice was a development cooperation travel to Bamba Project Orphanage. There was several reasons for this decision. In first place, my personal concerns about third world's culture, religion, problems and in conclusion, way of life. In second place, I wanted to feel and understand from my own skin what is it to live without many basic needs as tap water, electricity, proper transport and even food. In last place the numerous recommendations from my cousins that had already travelled several years before.

Before arriving, although I was nervous and frightened, I had no idea what I was going to find and how much I was going to fell in love with this country and its people. I performed several activities as teaching and helping the kids with school, construction, painting and visiting close villages... Although I was most of the time helping with daily tasks, soon became very concerned about a very interesting matter. Does really anything we do currently in a two months trip or with some economical help going to be enough for them to develop by themselves in the long term? Is this going to end up just with the tasks performed now?.

These questions really made me feel uncomfortable, even to the point of not wanting to come back to Spain and spend as much more time as possible there. I really lost attraction to any kind of comfort we are used on a daily basis and incredibly empathized with them. My next question was, how can I really help them improve their lives even when I am not there. The key point, for me, was education, specially high degree studies. This is the reason why I soon had the idea (3 years before finishing the carrer) of developing some kind of project with the help and knowledge of my University, Carlos III of Madrid.

After long conversations with the NGO manager and the two managers of the orphanage (Rutto and Christine in Figure 1), it was decided that one of the most needed things was a water management project. Their main problem was regarding storage space and consumption policy as a function of wet and dry season rain. Even though I was still on third year of University and the Final Degree Thesis was too far, it was clear for me that I wanted to dedicate it to them. Since them up to now, I have already gone another 2 months during summer 2018. During this time in Kenya I collected as much data as possible on many different fields and had interviews with as many people I could (between, them the major of the city, the water and agriculture minister of the County, workers at the water companies, people from the town...). All this before even knowing if the project was going to be accepted by the head of the Aerospace Department (due to, in principle, no relation with my studies), or having a tutor.

Figure 1: Rutto and Christine, parents and managers of Bamba

Since the first minute I took the decision of dedicating my thesis to this matter, I knew that many troubles would arise, and would frustrate me. Nevertheless, never lost hope and fought for making it as much as I could.

Finally, the project was accepted and I officially started with it. One of my main objectives was to make it sufficiently complex to be an aerospace engineer project, but useful enough to be able to be brought to action. In conclusion, my main motivation was to make **real** my final degree thesis and to be able to improve lives of the kids in Bamba. Besides, I thought of making the project concrete enough to be able to construct it in the orphanage, but with wide enough tools to be able to extrapolate it to many other places that would want to make use of it.

1 Introduction

Water is the most valuable resource on Earth. Even though there are some metals or minerals as gold or diamonds that seem to be much more expensive. What is the reason for that?
It is important here to introduce the different types of needs of the human being[1], that, according to Tashi Thakali are:

- **Basic needs** (we need them to survive): **water**, food, breathing, sex, rest ...
- **Primary needs** (we need them to feel safe): Security of body, employment, resources, morality, family, property...
- **Secondary needs** (we need them to function in society): Friendship, family, intimacy, information, clothing...
- **Tertiary needs** (we need them to feel better): Money, goods, luxury,

This classification was also made by Abraham Maslow in his 1943 paper “A Theory of Human Motivation”[2][1]. The main difference between both theories is regarding the top levels, where esteem and self actualization are given greater importance by Maslow. In the figure 2, a pyramid representing these needs helps visualizing these ideas:

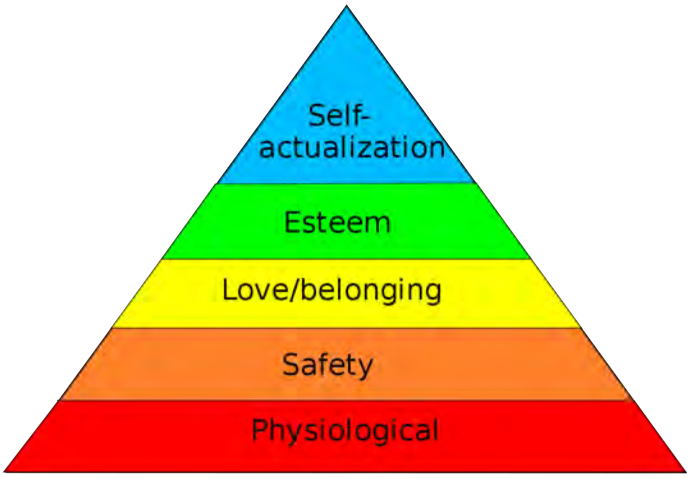


Figure 2: Maslow’s hierarchy of needs

As it can be now appreciated, water is much more valuable than other resources because it is a basic human need. In the case of the tertiary ones, life is not at risk as it is for the rest of the types of needs. Moreover, availability is another key point while valuing goods or resources. This is the reason why diamonds or other minerals are so expensive.

Most developed countries assume basic, primary and secondary needs are always covered, therefore, its importance is undervalued. Nevertheless, there are many countries where not even basic needs are covered and the amount of water, food and electricity is very insufficient or even unavailable.

This project will be centered on a small town called Kabarnet in the north of Nairobi (Kenya). There is an orphanage in this village run by locals with the aid of the NGO Bamba [3] Project.

[1]This classification was made by Tashi Thakali (Nepal) in 2013. Although, there are several different definitions, this seemed to be the most appropriate for the current matter

[2]This approach seemed to be too theoretical and not as appropriate as previous one for the project

[3]All information regarding this organization can be found on their official website: www.bambaproject.org

Figure 3: Location of the town in Africa

In figure 3 the exact position of the village can be found in the world map.

The NGO has been working since 2013 taking care of homeless children that had no other occupational alternative. Although, they have several other projects on the city as Neema woman, which is a community of women with different problems that make for them impossible to rise up their families. This organization offers them an opportunity of being independent from men and produce goods as bags, bracelets, t-shirts... to sell them locally, nationally and internationally to earn enough resources for living.

Figure 4: Neema Woman Organization

One of the main objectives by this final degree thesis, is to forge a plan or strategy, starting from scratch to achieve a sustainable model of energy and water consumption. It will be performed taking as data rain values from the local village for the last 33 years, several interviews to local authorities and citizens and data provided by the current managers, workers and parents of the orphanage called Rutto and Christine. The processing, study and analysis of results will be executed using the University Carlos III resources as: knowledge obtained during the grade (statistics, calculus, algebra, physics, fluid mechanics, business management, chemistry...), bibliography and information provided by different departments and specific teachers, computer software and, if possible, some economical founding.

In this project, not only water management, but also energy consumption will be considered due to the limited resources available. Moreover, an study on waste water will be made in order to analyze the possibilities of water recycling and different methods for this purpose. The final objective is to fulfill at least with basic and primary needs from the people leaving in the orphanage.

2 Objectives of the project

This project has several objectives that will be exposed and explained in detail in further sections. In order to provide the reader with a short summary of them, the following list indicates with a few words the main goals:

- Understand global, continental, and local climatology in order to develop an appropriate model for Bamba water management.
- Study and analyze rain data provided by local authorities (Table 12).
- Create a model that allows a prediction on the pluviometric values each day.
- Develop a tool that provides with the amount of water in the deposits depending on the inputs and outputs.
- Provide with a consumption policy that accomplishes certain requirements.
- Create a physical system that works under the model developed (Deposits and pipe connections with solar energy powered pumps).
- Implement this model embedded on their specific social, economical and political background.
- Execute the described model inducing the less possible impact on the environment, promoting the use of renewal energy sources.
- Obtain necessary budget and financing to provide Bamba with a feasible project.

As a conclusion, the **main objective** of this project is to offer Bamba the sufficient and necessary tools for them to manage their water resources with efficiency using the means and knowledge provided by themselves and the University.

It is important, before starting, to understand and visualize the global situation regarding water in order to have a deeper comprehension while explaining the actual Bamba environment.

3 The problem of water supply

3.1 Water Resources in the World

It might seem contradictory to say that water is everywhere in Earth, as this compound, H_2O is present in most living beings and can be found in several states. Although, the problem is that the amount of water available for drinking or cooking purposes is a extremely low percentage of the whole amount on the planet. This can be appreciated in figure 5:

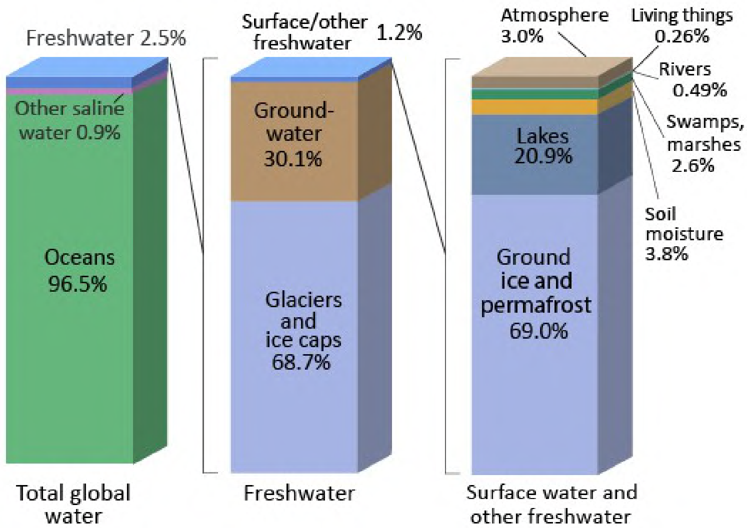


Figure 5: Distribution of Earth's water

Data from this figure [2]can help us make an idea of the very small percentage that is actually available for human consumption. For example, to calculate water from rivers (which is not always drinkable) we should proceed as follows:

$$Water_{rivers} = 2.5\%(Fresh) \times 1.2\%(Surface) \times 0.49\%(Rivers) \approx 0.0002\% \quad (1)$$

Water source	Water volume, in cubic miles	Water volume, in cubic kilometers	Percent of freshwater	Percent of total water
Oceans, Seas, & Bays	321,000,000	1,338,000,000	–	96.5
Ice caps, Glaciers, & Permanent Snow	5,773,000	24,064,000	68.7	1.74
Ground water	5,614,000	23,400,000	–	1.69
Fresh	2,526,000	10,530,000	30.1	0.76
Saline	3,088,000	12,870,000	–	0.93
Soil Moisture	3,959	16,500	0.05	0.001
Ground Ice & Permafrost	71,970	300,000	0.86	0.022
Lakes	42,320	176,400	–	0.013
Fresh	21,830	91,000	0.26	0.007
Saline	20,490	85,400	–	0.006
Atmosphere	3,095	12,900	0.04	0.001
Swamp Water	2,752	11,470	0.03	0.0008
Rivers	509	2,120	0.006	0.0002
Biological Water	269	1,120	0.003	0.0001

Table 1: World water split into percentages

In table 1, data from the source in the following link [2] has been processed using equation 1. Visual representation of this values is according with figure 5.

Taking this frightening data into account, it becomes now even more clear why this is a very poor resource that needs to be properly managed.

Moreover, there is a very important fact that has not been taken into account, and it is **Global warming**[4]. The relationship between this effect and water, energy, agriculture... is very complex.

[4]This problem will not be treated in depth due to its complexity, although it plays a key role in this field. For more information, the NASA gives live data that can be checked so as very accurate definitions and explanations [3]

Explained with the words of Water Disclosure Project CEO, Paul Dickinson: *"Much of the impact of climate change will be felt through changing patterns of water availability, with shrinking glaciers and changing patterns of precipitation increasing the likelihood of drought and flood.* ***If climate change is the shark, then water is its teeth*** *and it is an issue on which businesses need far greater levels of awareness and understanding."*

Climate change leads to an increase of Earth's mean temperature. The principal reason is the greenhouse gas emissions that deteriorate the Ozone layer, producing a big accumulation of solar heat and radiation inside the atmosphere. This has had an astonishing effect for the past 50 years, and seems to keep increasing even with current protocols to reduce them as Kyoto [4].

This is an undeniable evidence proved by several organizations as can be observed in figure 6:

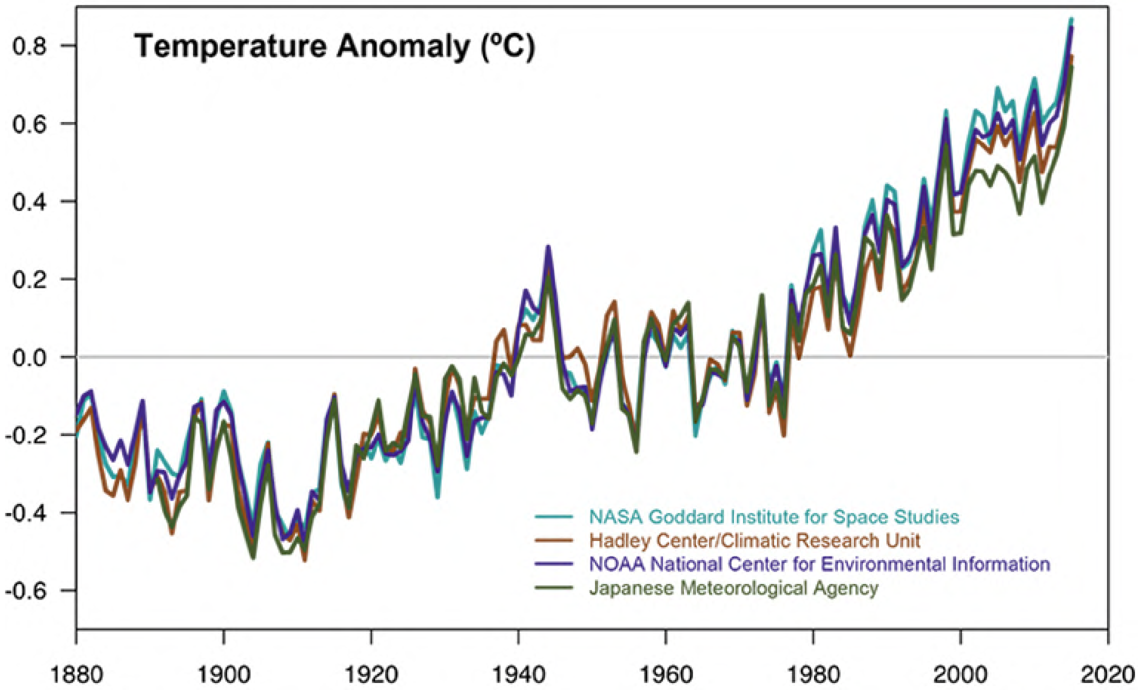


Figure 6: Increment of global temperature from 1880

There are diverse numerous effects and consequences from this increment of temperature according to last NASA reports [3]:

- **Frost-free season and growing season:** The appropriate season for agricultural growing of determined species and the corresponding frost-free season have lengthen and will continue to [5]. This will significantly change natural ecosystem patterns, affecting consequently biodiversity and agricultural quality. It can be easily observed in Figure 7 how in the northern part of the globe, for the same day, frost-free region has been increased significantly from 2009 to 2011.

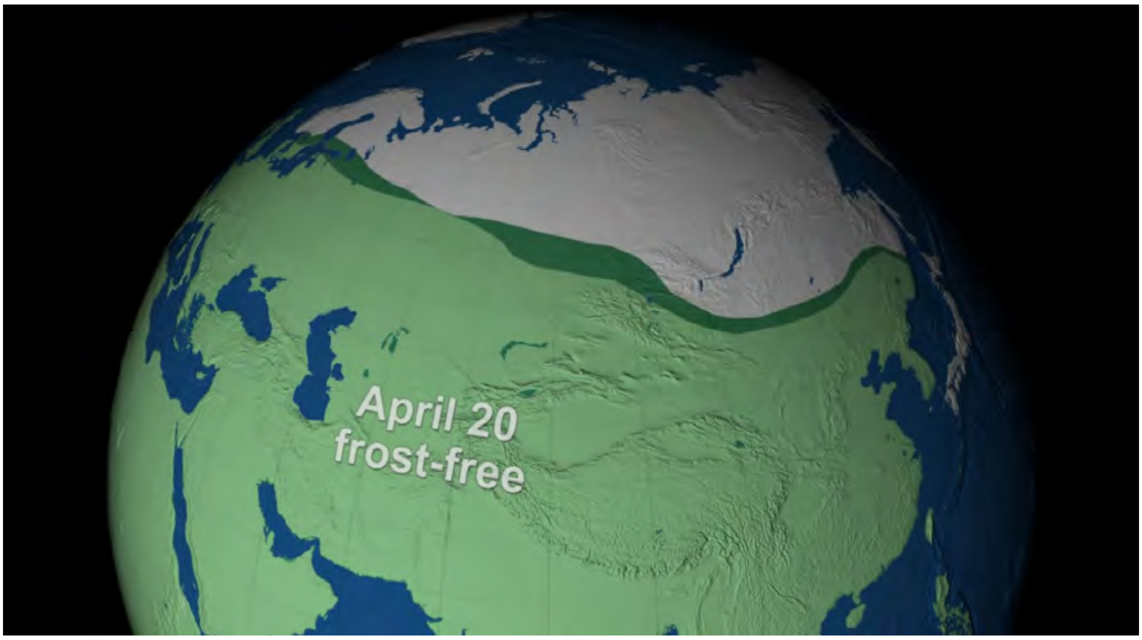
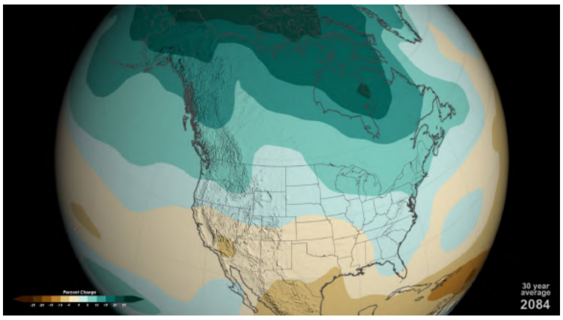
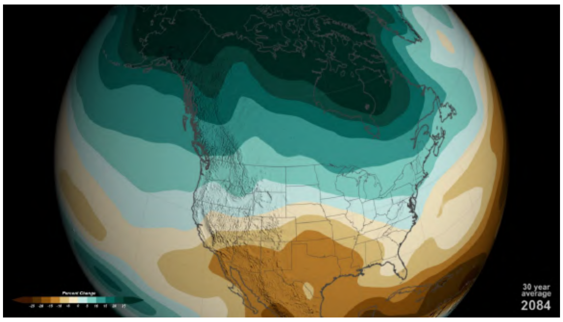


Figure 7: 20th of April frost-free region in Asia for 1950-1952 compared to 2009-2011 data.[6]

- **Precipitation patterns:** It is a fact that all over the world rains have changed its sequences whether in amount or in time.[7] As a visualization example, US data will be used to show how this precipitation patterns will continue to change over the years:



(a) Low emissions



(b) High emissions

Figure 8: 30 years percentage change in precipitation [8]

In Figure 8 it is easy to see and compare future scenarios on the precipitation increase or decrease. Even with emission reduction protocols, it is already very difficult to stop this effect from happening, but if nothing is done changes in these patterns might go up to a 25% change. As expected, major percentage decreases appear around the equator while increase happens to be around the poles. This worsens the situation for both dry places and ice storage regions.

- **Droughts and heat waves:** As a consequence from previously stated precipitation patterns, droughts will become more common every year. Taking into account the increase in temperatures along with this, heat waves could be devastating for both flora and fauna of any biological system. According with NASA's Science Advances report [9], 21st century could be drier and longer than anything humans have seen in the last 1000 years.

(a) Year 1963

(b) Year 2095

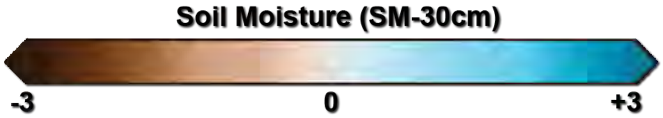
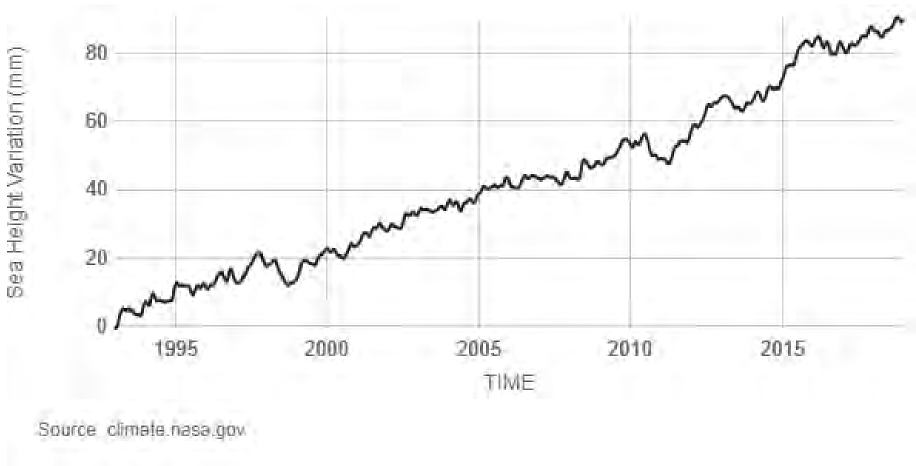


Figure 9: Soil moisture in surface down to 30cm. [10]

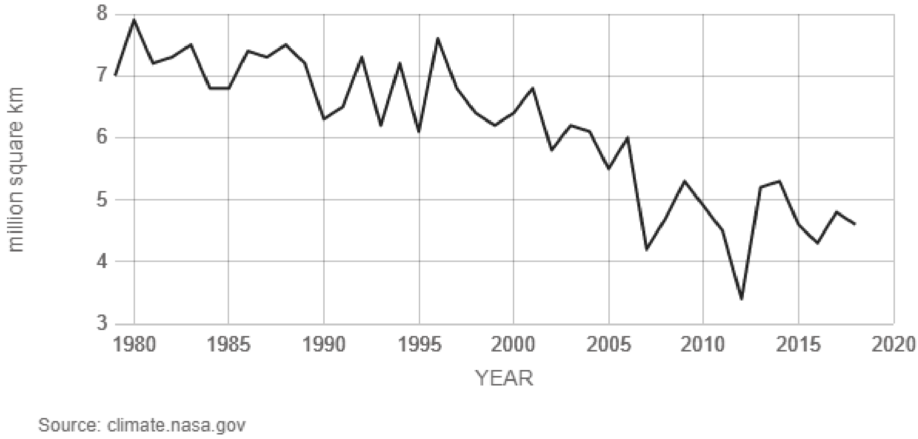
In Figure 9, it is observed how southern regions of the American continent have decreasing soil moisture while northern regions increase it. Ben Cook, a climate scientist of NASA's Goddard Institute for Space Studies, has stated one of the biggest consequences with two simple phrases: *"Natural droughts like the 1930s Dust Bowl and the current drought in the Southwest have historically lasted maybe a decade or a little less". "What these results are saying is we're going to get a drought similar to those events, but it is probably going to last at least 30 to 35 years".*

- **Hurricanes:** Even though there is not a clear relationship between human activity and hurricane-associated storms and their intensities, there is data that proves that category 3 or more hurricanes have increased since 1980[11].
- **Sea level:** There is a clear and doubtless relationship between global warming and ice melting. Ice sheets and glaciers are becoming seawater, therefore reducing the amount of fresh water. Moreover, the sea level is rising at an astonishing rate of 3.3 mm per year[12]. This is a total of 90mm from 1993 to the present. Directly related to this, minimum Artic ice level is decreasing 12.8% per decade[5].

[5] Data related to these values can be downloaded from https://climate.nasa.gov/vital-signs/sea-level/



(a) Sea level increase since 1993



(b) Year 2095

Figure 10: Soil moisture in surface down to 30cm. [10]

Figure 10 shows the clear relationship between the two previously mentioned figures.

- **Artic ice:** 400 billion tons has been the total glacier loss per year since 1994[13], as shown in Figure 10b.

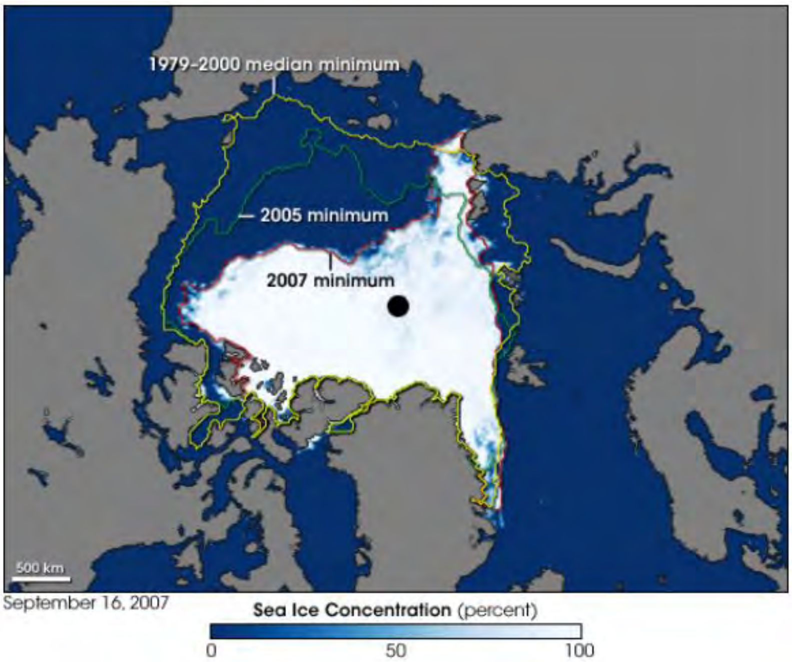


Figure 11: Ice concentration from 1979 up to 2007

Figure 11 clarifies by yellow, green and red lines the different positions of the ice concentration on the Artic Pole[6]. By 2007, sea ice achieved a record low, nevertheless, the situation has worsen since then.

3.1.1 Water resources in developed countries

Usually, in first world countries, industrialization and economy allow having nearly endless water for every citizen, even where there is very few sources. There are several extraction and purification methods that are very expensive but affordable for this particular cases. Offer and demand laws apply then, rising its price when this asset is lacking as in desert rich countries like the United Arab Emirates.

According to CIA World Population Review [14], first world countries [7] in 2019 are the following: Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Slovenia, South Korea, Spain, Sweden, Singapore, Switzerland, Turkey, United Kingdom and United States.

The United Nations Educational, Scientific and Cultural Organization (UNESCO), provides with an open source .pdf files [15] that, in accordance with the Food and Water Organization (FAO), grant general water data for every single country of the world. Some of it can be really interesting if compared between different places, for example: Precipitation Rate, Total Annual Renewable Water Resources (TARWR), TARWR per Capita, Surface Water, Ground water, Incoming waters, Outgoing waters and Total Use of Waters[8].

The data obtained from this file, for developed countries, is shown in the appendix Tables 10 and 11

Processing this data [16], several plots were obtained with very interesting results.

[6]This image shows the Arctic as observed by the Advanced Microwave Scanning Radiometer for EOS (AMSR-E) aboard NASA's Aqua satellite

[7]First world developed countries can be categorized in many different approaches. Although, regarding CIA, high-income countries are those with per capita GDP exceeding $15000.

[8]The total Use of Waters is a percentage of the TARWR, which does not necessarily mean that 100% is the maximum, as some countries might spend more water than they actually have available by taking it from out-shore reservoirs or buying it internationally

Regarding climate change, mentioned in section 3.1, an important influence on the TARWR can be observed in figure 12 in the short period of time of 5 years (2000-2005):

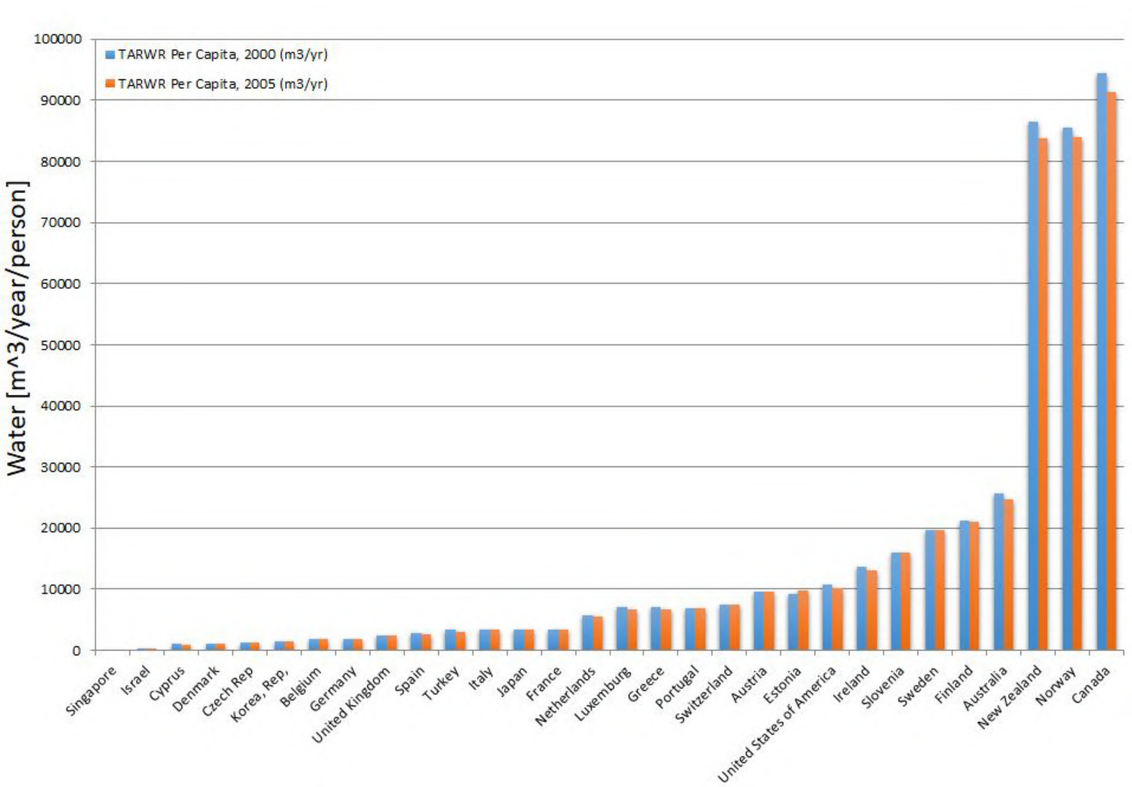


Figure 12: Decrease of Water in developed countries from 2000 to 2005

Higher values are around northern countries not only due to the amount of ice water but also due to the small population compared to other countries. Nevertheless, the important fact to bare in mind about this graph is that nearly for all the countries, there is a reduction of 500 to 1000 m^3 of water **per person** in only five years.

In addition, incoming and outgoing water for each developed country give interesting results in figure 13[9]:

[9]Some countries as Korea, Ireland, Israel, Portugal... have missing data (on some fields) on the source document for political or practical reasons. Available data has still been plotted

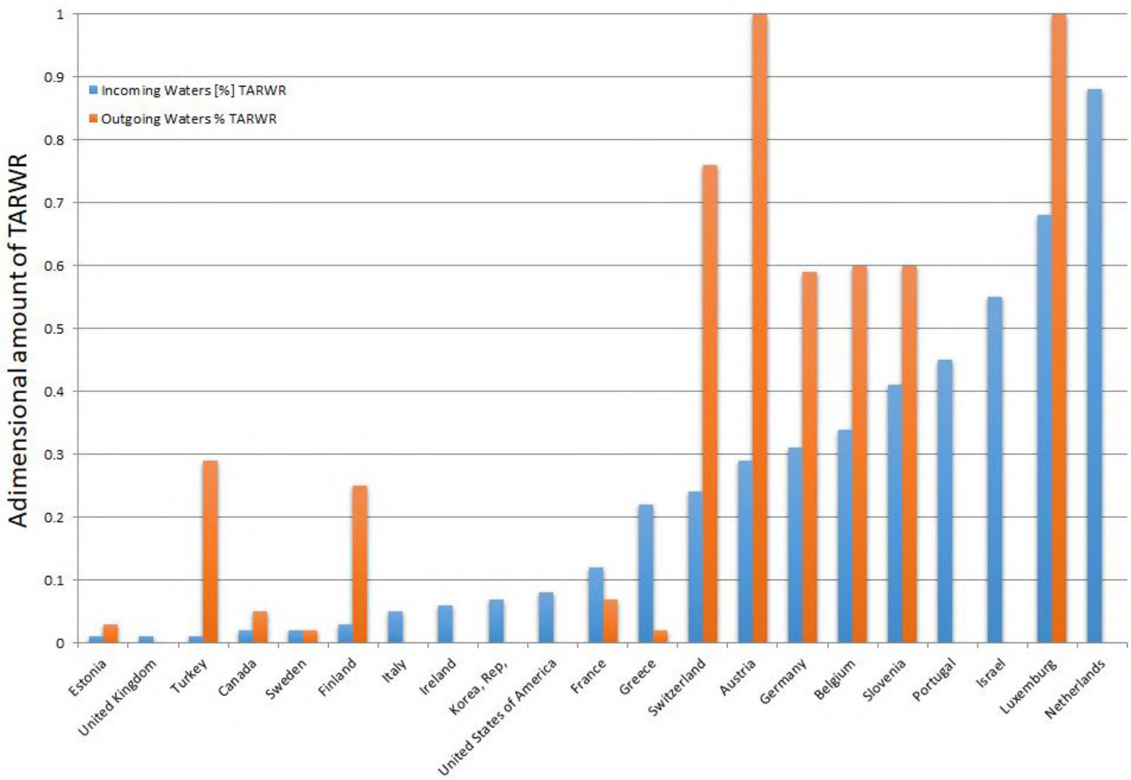


Figure 13: Incoming and outgoing water in developed countries

It can be appreciated above that incoming water (as a percentage of the TARWR) is, except 3 specific countries, always lower than the outgoing water. This might seem unreasonable in the long term, but actually has a reason. Most of the ground water does not get renewed in the actual year measurements are being taken, therefore although shortage seems to be happening, in the overall computation, the amount of water remains nearly constant. The problem arises when analyzing the renewal time for the pure, available for consumption water, underground water. If it takes a longer period than the rate of consumption, as it is happening in most of the developed countries currently, the overall sum becomes smaller every year, leading to long term deficit problems.

3.1.2 Water resources in under-developed countries

In the other hand, for poor countries[10], methods and technologies for extraction and purification of water mentioned before are not available, leading to huge problems including, in worst cases, deaths and wars.

Plotting data from figures 12 and 13 but for undeveloped countries several differences are observed.

In first place, when comparing rain data from 2000 to 2005:

[10] Third world or undeveloped countries can also be categorized in many different approaches. Although, regarding CIA,low-income countries are those with per capita GDP under $3000. Developing countries as Kenya, are supposed to be in-between this bracket ($3000 to $15000)

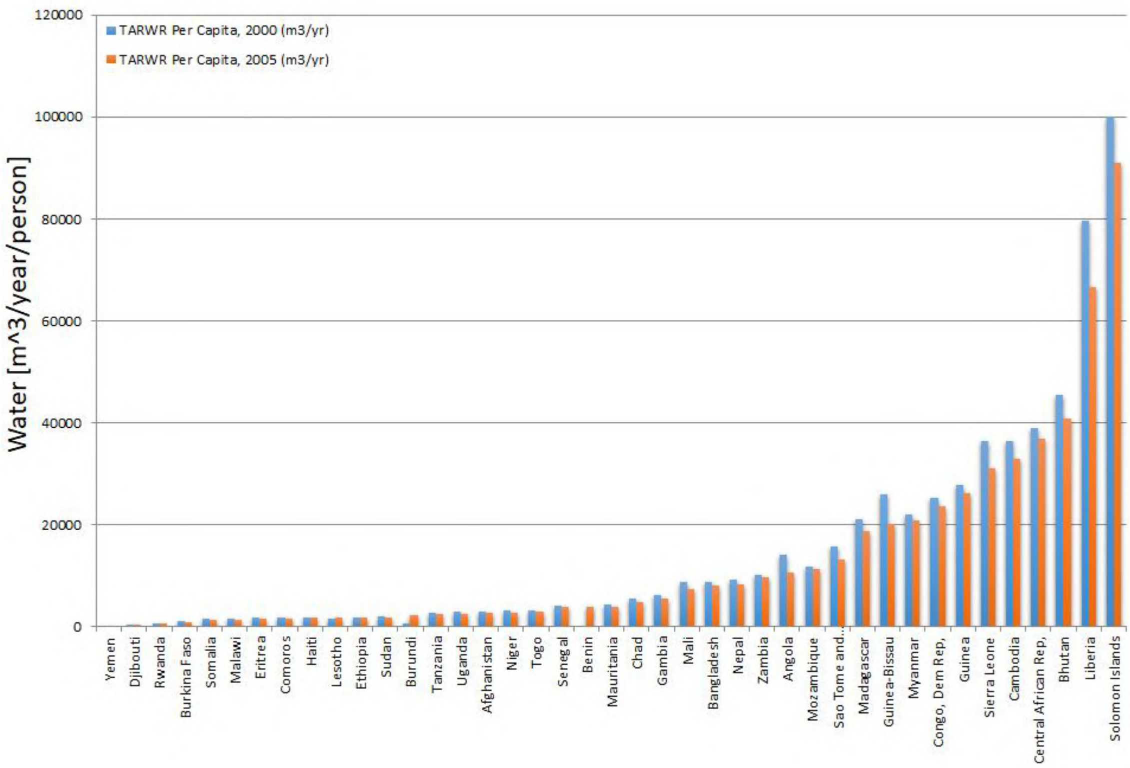


Figure 14: Decrease of Water in undeveloped countries from 2000 to 2005

Figure 14 shows, in this case, that the decrease on the amount of rain per capita is much wider than in the case of developed countries for most of the cases. This astonishing data demonstrates that climate change is affecting much worse to the countries that are really in the need of this basic resource.

Besides, hopeless results are obtained while graphing the incoming and outgoing water for this countries:

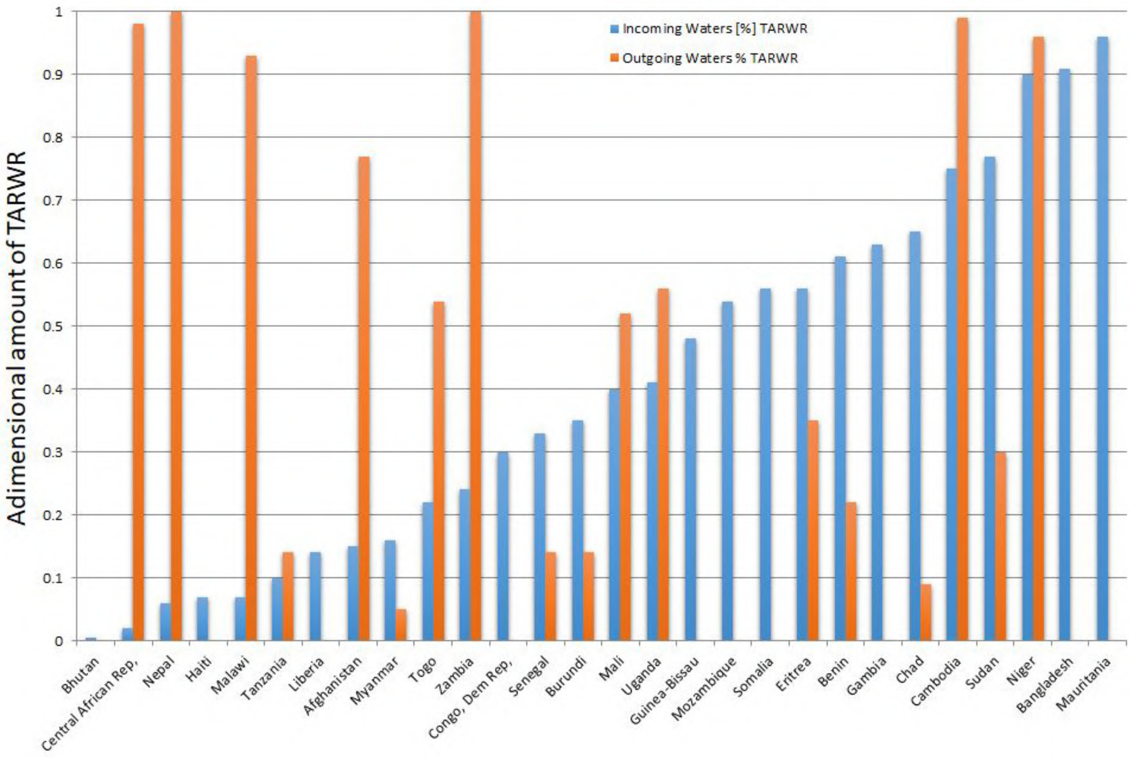


Figure 15: Incoming and outgoing water in undeveloped countries

Figure 15 provides with similar values for incoming water than in figure 13, although, outgoing water have really high peak values for several countries. Specially those with smaller incomes of this valued resource, reaching values really close to 1, which means that the whole amount of Annual Renewable Water is outgoing. The difference between these two values is the actual reason why in countries like Central Africa, Nepal, Haiti, Malawi, Tanzania... have terrible water problems.

As before, data obtained for this table, for under-developed countries, is shown in the appendix Tables 10 and 11

3.1.2.1 Comparison between First and Third World countries

When comparing several rain quantities from previous data selection, there are many unexpected and encouraging results. For example, in first place, for the amount of rain per year, these results are given:

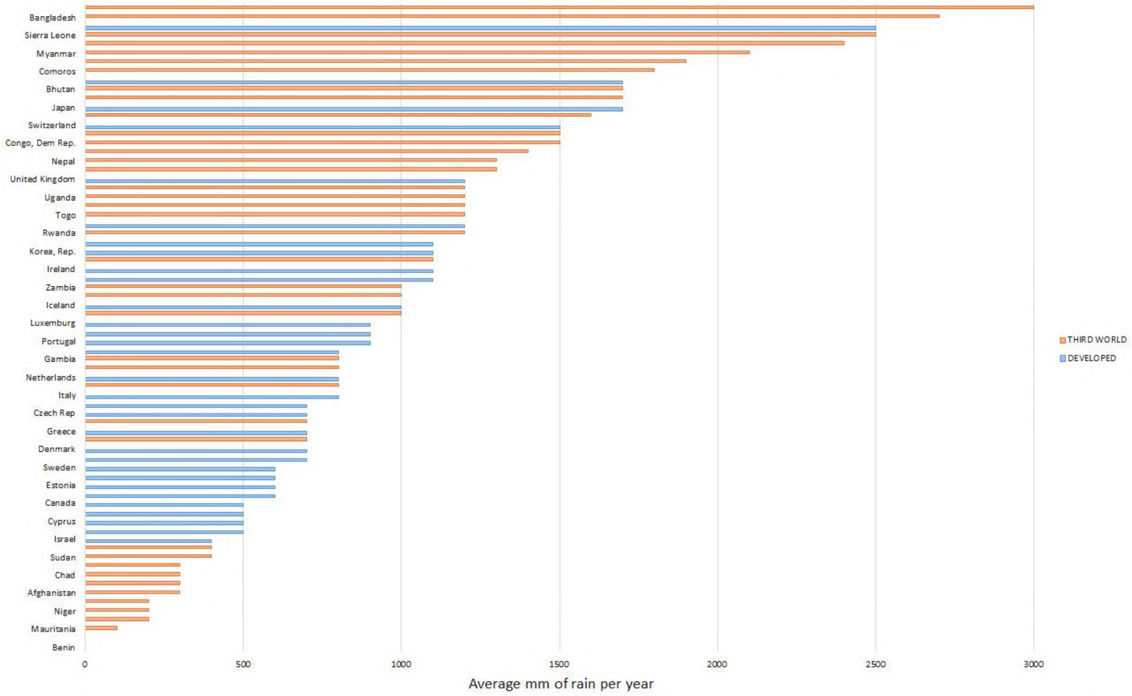


Figure 16: mm of Rain per year for both developed and underdeveloped countries

As it can be appreciated, most of the third world countries are positioned above in figure 16. This appears to be incoherent and induces several questions. One may think, why is there so much problem regarding water resources in these countries, when data shows that they have clearly more rain than developed countries? The question can be answered regarding several aspects. In first place, regarding technology, in the present, the relation with economical founding is direct, therefore, if there is not enough budget for water accumulation or filtration, higher amounts of rain will not give bigger consumption water available. In second place, and in relation with first reason, as it will be seen further on, rain season is much more concentrated in these countries as they are usually located closer to the Tropic of Cancer or Capricorn (Kenya is one of the best examples). This means that there is an impressive amount of rain water during a very short amount of times, leading to floods, contamination and exceeding accumulation capacity. Furthermore, they usually receive very few amount of rain during the long dry season, therefore, the collected water finishes earlier.

In figure 16, it can also be observed that bottom countries as Mauritania, Niger, Afghanistan, Chad, Sudan... are the nations with less available rain water resources, producing even bigger problems for accumulation purposes.

Another interesting detail to be shown is the comparison of Surface and Ground water:

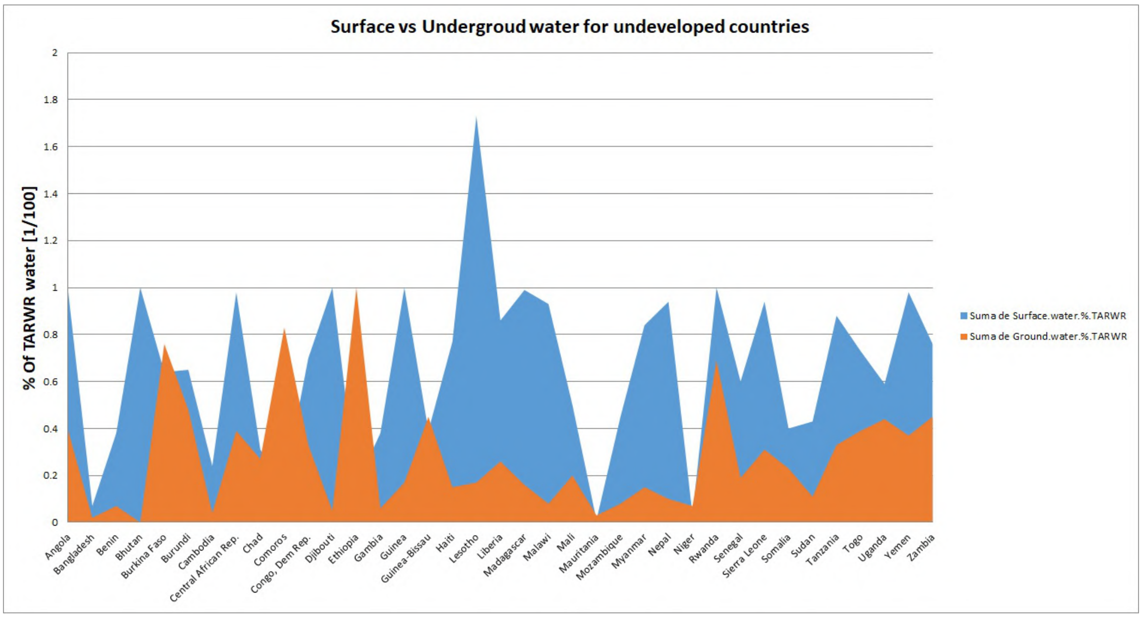


Figure 17: Surface vs Underground water for underdeveloped countries

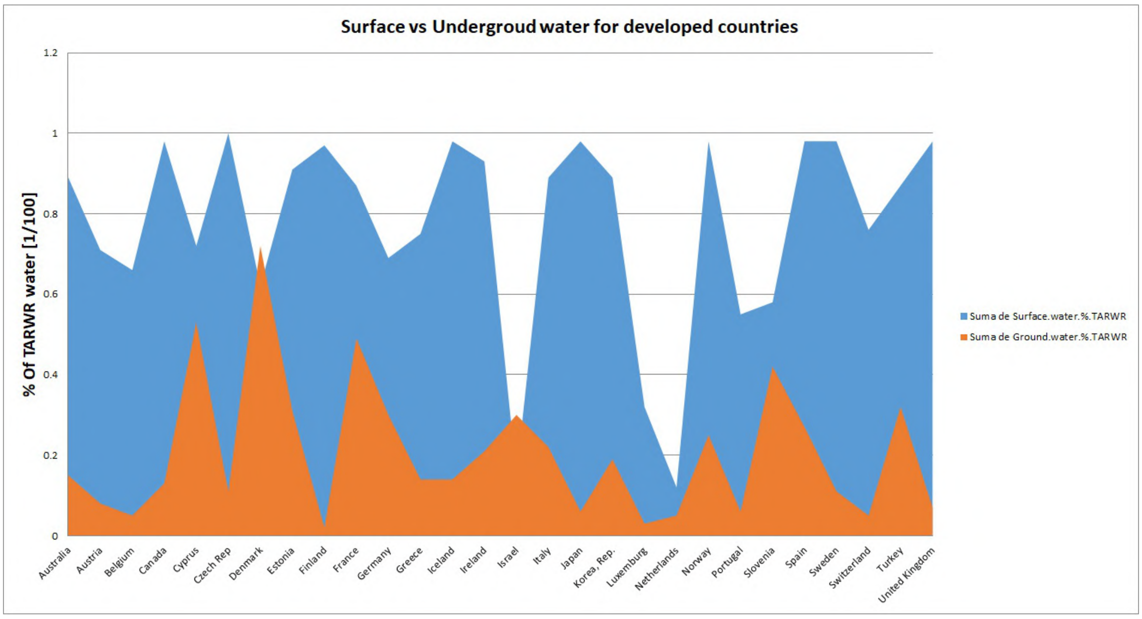


Figure 18: Surface vs Underground water for developed countries

Even though ground water resources seem to be similar, regarding surface water it is clearly a higher amount in developed countries. The reason follows previous statement. As technology and financing allows for better management of the resources, artificial lakes and dams can be created, increasing the available amount of reservoirs of water. Even in the situations where surface water is not possible to be accumulated due to lack of rain, extraction water wells can be built to increase the accessibility to this resource. This is something nearly impossible in most situations in poor countries due to the lack of machinery, budget, knowledge or work-hand.

As a final world wide conclusion, a map is shown in figure 19:

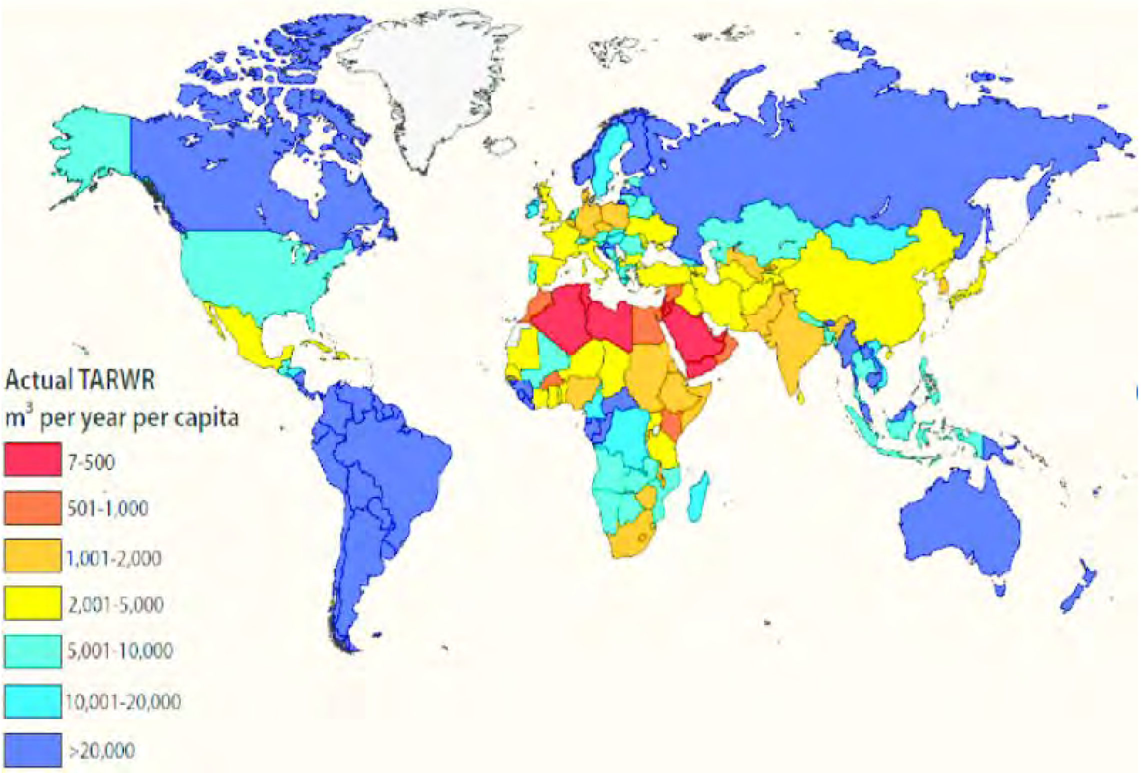


Figure 19: World map of TARWR

As expected, northern and southern countries close to the poles have big reservoirs of water in the form of ice and most dry countries are condensed close to the equator.

3.1.3 Water Use

According to the Statistics National Institute (Instituto Nacional de Estadísitica, INE) [17], Spanish citizens have spent, for domestic use, an average of 130-137 litres per person per day since 2012 to 2016. Although it is an sufficiently high amount, virtual water[11] is not taken into account. **Virtual water** [18] is a concept referred to the water footprint left for every single good that we buy, consume, or use. For example, 1 kg of chocolate takes up to 24000 liters of water to be produced [19]. This is due to the agricultural cost of growing the grain, the producing cost, the manufacturing cost... Taking this into account, it becomes easier now to understand the incredibly high impact that every single human being has in many parts of the world. (For example, water spent for the chocolate that is consumed in Spain, was spent in Colombia in the case of obtaining the cocoa from there).

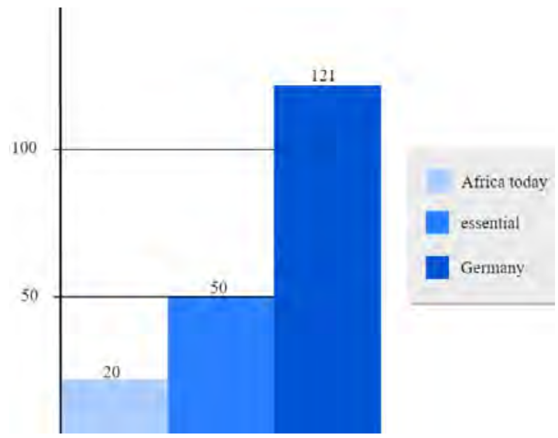


Figure 20: Average water use per person and day

Moreover, the United Nations calculate that around 2.12 Billion tons of water is **dumped** globally every year [20]. 99% of the goods we buy are trashed within 6 months.

[11]In the following link, a live counter with many interesting data can be found: http://www.theworldcounts.com/

Data previously mentioned is frightening, and even more when it is compared with the same criteria for underdeveloped countries. According with the Food and Agriculture Organization of the United Nations [21], Africans have only access to an average of 20 litres per day, which is nearly 10% of the amount an Spanish citizen can gets. It has been studied by the World Wide Fund [22] that, in order to maintain enough food, water and hygiene levels, an average of 50 liters per person and day are needed. This is one of the main reasons for deaths in Africa. In addition, water in poor conditions produces several diseases as cholera, which increases the death rate when this resource is insufficient.

3.2 Water resources in Kenya

Even though this Country is in Africa, its weather has nothing to do with the dry idea of dessert one might have. Actually, the nation has several different climates and, some of them, full of flora and fauna of very diverse varieties.

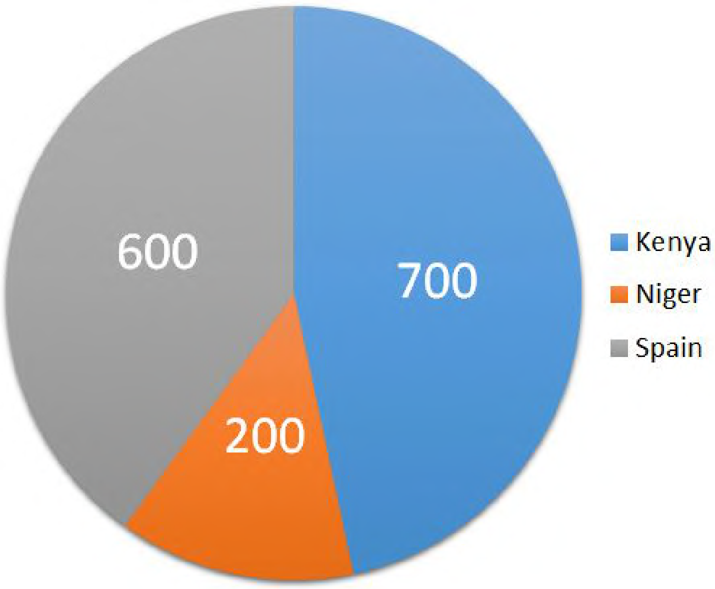


Figure 21: Rain comparison between Níger, Kenya and Spain (mm/year).

As it can be seen in figure 21, obtained from data at the FAO-AQUASTAT [15] report as in section 3.1, there is even more rain resources in Kenya than in Spain. This is due to the geo-localization of the country, close to the country. Climate changes severally in Africa when displacing south from the equator where, for example Niger is (Kenya has nearly four times more rain than these countries).

In table 2 several interesting data are provided for the above mentioned countries for comparison between them:

Country	Kenya	Niger	Spain
Use Waters, % TARWR	0.05	0.06	0.32
Outgoing Waters, % TARWR	0.3	0.96	0.31
Precip Rate (mm/yr)	700	200	600
Incoming Waters, % TARWR	0.33	0.9	0
Population, (1 000s)	32420	12415	41128
TARWR Volume, 2005 (km3/yr)	30	34	112
Ground water, % TARWR	0.1	0.07	0.27
Surface water, % TARWR	0.57	0.03	0.98
TARWR Per Capita, 2005 (m3/yr)	930	2710	2710

Table 2: Water resources data for Niger, Kenya and Spain

3.2.1 Social, political and economical framework

Kenya is a country that has 47 different counties that are ruled by elected governors. Its political system is a unitary presidential constitutional **Republic** and their currency are Kenyan shillings (KES). Official Language is Swahili, although there are several different tribes that speak different languages.

It is considered a developing country, with GDP per capita of $1991 according to the International Monetary Fund [23]. Their main source of income at the economical level is agriculture, as they export mainly Tea (18%), flowers (10%), coffee (4.6%), Petroleum (4.7%)... Nevertheless, the second bigger source of income is tourism. The nation has 60 different national parks and natural reserves. They are considered to be the best on the world due to the fauna and flora diversity that can be found, with nearly no pollution, as they are away from the main cities as Nairobi.

Even though from a macroeconomic point of view the country has grown at a very fast rate, most part of the income does not finish on their population. This is due to exploitation by foreign companies or countries that take profit from the cheap labour cost and amount of valuable resources. According to the University of Michigan [24], in 2005 17.7% of the people leaved with less than $1.25 a day. This means that even though they are a rich country from the natural resources point of view, from the local economical one, their citizens usually get no real profit from the goods that are being exported, leading to slower development and poverty.

Moreover, Kenya has been British colony until December 1963, when they were declared Independence.

There are several different cohabitant tribes in the country and their way of life depend on the local resources that are available. Usually first sector, as they produce fruits, vegetables, milk, meat... that can be easily sold in the small villages.

Kenya has been always well known because middle-distance and long-distance athletics, bringing them to the top of Olympics in many situations. Nevertheless, there are some other important sports as cricket, rallying, rugby and boxing.

3.2.2 Water resources in Kabarnet town

Kabarnet town has two main sources of income water. In first place, rain water, which provides insufficient resources for the houses, specially those that have not means of accumulation. In second place, rivers and lakes treated water. As provided by several interviewees, (seen in Appendix, Section 11), Kirandich Dam is the major and main source of water accumulation of the city.

3.2.2.1 Lake Baringo and Lake Bogoria

Lake Baringo is one of the bigger lakes in Kenya, situated in the middle of the Rift Valley, and a surface of 130 square kilometres. It is 970 m above sea level[25]. Its income comes mainly from rivers Molo, Perkerra and Ol Arabel and, even though there is not a known outcome, according to the interviews in the appendix (Section 11) it is connected via underground waters to Lake Bogoria. This is a reasonable thought, as it is common to see several hot-springs when one of the lakes has a grater level than the other. It has an astonishing bio diversity[26], having beautiful pink views depending on the season due to the flamingos[12]

[12] Figure 22 source: AirPano [27]

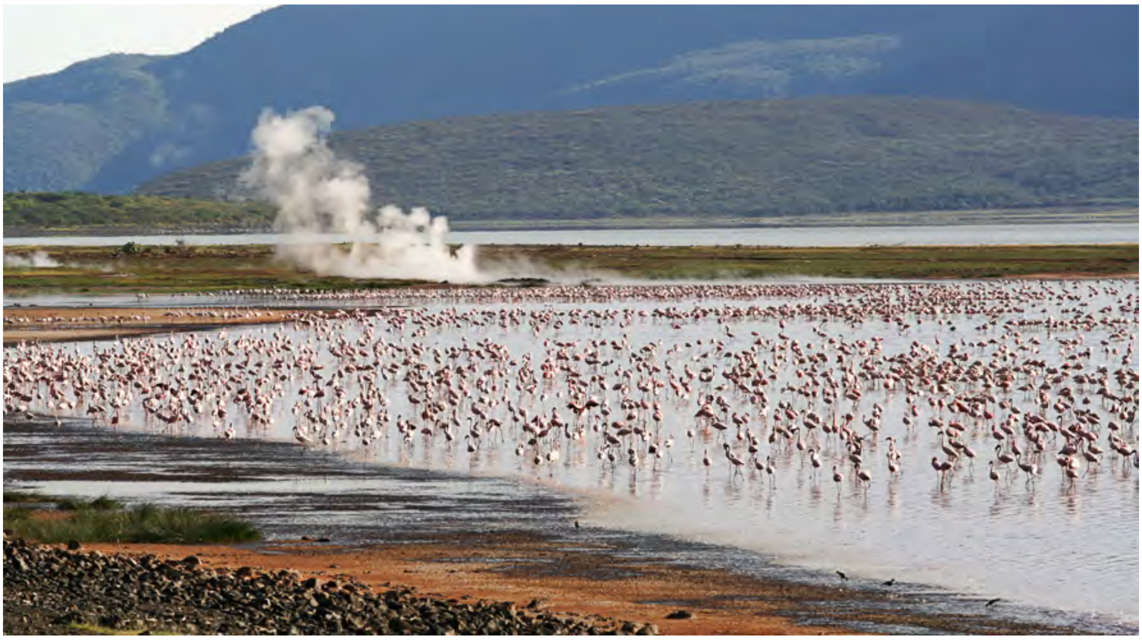


Figure 22: Lake Baringo

Lake Bogoria is around 20km at the south of Lake Baringo, at around the same elevation above sea level. Even though it appears to be smaller on the map (32 square kilometres), it has a much bigger catchment area (700 square kilometres). Similarly to Baringo, it has one of the biggest concentrations of hot springs of the whole country[28], which approves the theory of being connected through the underground as many local workers state [13].

Figure 23: Lake Bogoria Hot springs

The lake contains very large concentrations of Na^{+}, HCO_3^{-} and CO_3^{2-}[29] due to the volcanic origin. This leads to several teeth and stomach problems for the locals who drink this water[14]. Even when it is boiled, there is several residuals that harm their health.

3.2.2.2 Kirandich Dam

As previously mentioned, government water provided to the citizens of Kabarnet town comes from Kirandich Dam. The enterprise exploiting this resource is a public concession to a private company

[13] See appendix Interviews (Section 11 and Figures 82 and 83)
[14] Information obtained from the interviews provided in the Annex 1 (Section 11)

called Kirandich Water Company Ltd.

In this complex, several tasks are being preformed[15]. In first place, the amount of water can be controlled by releasing it when there is lack of it during the dry months of the year and accumulating it during the rain season. Maximum capacity is around 4.000.000 m^3 and its level goes down around 1.5 to 2 meters from one season to another. This means that even when there is important water insufficiency problems, there are still available resources, the problem is that they become more expensive. This is due to the following: water is pumped from the dam to the city tanks, which get emptied very rapidly during dry season. As a consequence, a water truck is needed to transport this resource to everyone's home, meaning extra costs for fuel and delivery.

Another task being carried in Kirandich Dam is the treatment of its water (Figure 24) before it is pumped to the city. This is one of the most important points, as there are usually several microorganisms and chemicals that could harm severely the health of Kabarnet Citizens.

Finally and most important, the kinetic energy obtained from letting the water drop from a higher to a lower level is converted into electricity using turbines, which lights up nearly 40% of the whole energy demand of the city.

There are a total of 4.000 pipe connections for the whole city (which has around 24.000 habitants), while the Dam was designed, in principle, to be able to supply enough water resources for 70.000 people.

Figure 24: Kirandich treatment plant

3.2.3 Underground water availability

According to the information provided by the Water management Minister of the County, Mr. Kiplagat[16], obtaining water from the underground is nearly impossible. There are several reasons for it:

[15]See appendix for a reference to the interviews taken to the workers of the dam (Section 11)
[16]See appendix Interview in Section 11

In first place, as he stated: *"The terrain is mostly rock, which makes it hard and expensive to perforate the ground down to subterranean water bubbles"*.

In second place: *"It is necessary to dig down to 120-200 m of depth to find drinkable water"*. This is due to the bad quality of water that can be found in more superficial levels from 10 to 50m. This is mostly due to the pollution and contamination of the superficial waters that are not passed through a sewage treatment plant before being thrown to the river. Moreover, there is no sewage underground system, so it is the earth that cleans all the water and chemicals. This implies bad quality water at superficial levels.

In last place, economical reasons. According to the Director of Water Management of Baringo County, *"The price of a water well, taking into account materials and workforce is around 7000 Kenyan Shillings (KES) per metre deep. Therefore, making a total of 840.000 KES to 1.400.000 KES."* In euros, this is approximately 8.000€to 12.500€which, taking into account Kenya purchasing power it is nearly impossible to be financed if no foreign organization provides with a subsidy.

3.3 Bamba Children's Home

3.3.1 Introduction

As previously mentioned, Bamba children's home is an orphanage in Kabarnet town (Baringo county), in the middle of Rift Valley. It was born 9 years ago (2010) from another home called Sunrise. Sunrise is situated just several metres away from Bamba. Rutto and Christine were the couple in charge of these kids, under the management of the government. As it could be expected, the amount of resources for them and the kids was very small, due to this, they were forced to ask for money or food in the village.

In a trip to Kenya, Rocío Cabeza Oliver (actual manager of the NGO) found them begging for food to the kids. Guided by her instinct, she decided to talk to them in order to know more about their story. She went with them to Sunrise and saw their life conditions, including the insufficient water availability. Impulsed by the urgency of covering at least their basic needs, some time later, she contacted them to share an idea. The idea of creating an NGO that could help them and the kids grow safe and healthy with some founding from her and contributors. Progressively, some Spanish people were starting to know about Bamba Project and travel to the orphanage to help in many different fields. This made them bigger quickly, up to the point of needing a bigger house for all the kids and the travellers. This is what brought to life Bamba Home.

Figure 25: Bamba Home entrance

As it can be seen in Figure 26, Bamba is conformed by two main buildings and several additional houses[17]. Buildings around number 1 are the facilities of the kids, including girls room, boys room, babys room, kitchen, studying room, dining room and television room. The house number 2 is Rutto and Christine's home. The number 3 refers to the Christine's office, where all the legal paperwork is performed. Additionally, there is another room at the back for situations with several

[17]Please, refer to Annex 3: Bamba building Diagrams in order to visualize the architectural map sketch.

travellers. Moreover, houses 4, 5 and 6 are more houses for the travellers. Number 7 is the orchard where they produce some of the goods consumed in the orphanage. Finally, number 8 refers to the main deposit for the current water management project and number 9 to the sewage water tank.

Figure 26: Bamba Home door

During the year, approximately 25 children leave there. There are also some workers that live with them (usually one or two per night and four during the day). Moreover, kids from the neighbourhoods go for lunch with them from time to time. Therefore, adding Rutto and Christine, between 40 and 45 people leave on a daily basis in Bamba home (not taking into account travellers).

3.3.2 Infrastructure

First of all, it is important to visualize the geographic environment where Bamba is built. Due to its positioning in the middle of the Rift Valley, there is a notorious height difference between different points inside Bamba field.

Figure 27: Water deposits along the field

Their infrastructure regarding water resources is:

- **Plastic Tanks:** For the girls and boys showers two deposits of 2000 and 2300 L each numbers 1 and 2 in Figure 27. For the main house one deposit of 5000 L (Number 4 in Figure 27). For the kitchen another one of 2300 L (number 3 in Figure 27). Finally, for the travellers one of 5000 L (number 5 in figure 27).

- **Cement tank:** Deposit constructed on summer 2018, with a capacity of 24750 L and the purpose of saving water during the rain season and manage its consumption during dry season (number 8 in Figure 26).

- **Sewage water:** There are two main places where flushing water goes to. First one is close to the girls and boys toilet and collects water from them so as the cleaning room and the showers (number 6 in Figure 27). The second one is on the bottom part (number 9 in Figure 26), lower than the travellers houses in order to be able to receive all the used water from them (showers and toilets).

Regarding the **income water**, their two main sources are rain and government water. Rain water is collected from the roof of the two main buildings using roof gutters.

Approximately 233.5 m^2 of effective roof were measured, taking into account that not all of it was collecting rain.

Government water arrives, in principle, following an schedule of hours at which they are supposed to get a certain amount of water. This can be seen in the appendix I (Section 11) in Figure 84.

Although, this schedule is usually not followed[18], which means that they are only able to receive water from the public services depending on the season and the amount of houses requesting for

[18]This information is taken from the interviews in Annex 1

it at the same time. This is due to pressure problems from the main deposit of the town and the height at which the requesting house is positioned. This means that, as the amount of water depends on the flow rate, but the schedule limit your access to water to a certain amount of time, houses positioned higher on the valley will have less pressure due to smaller height difference from the storage and their access point. On the other hand, houses with higher positioning difference from the supplying main deposit and the receiving point, have much more pressure, which leads to higher flow rate and considerably high overall amount of water in litres compared to previous cases.

Moreover, pipes bringing the water from Kabarnet storage tanks, subdivide several times before arriving to the destination home [19]. Subtracting pressure losses and the uncountable amount of water lost during bifurcations, pressure available at a certain point depends on the amount of houses or people that are being supplied by the same pipe, the length of it, the amount of bifurcations...

All this uncertainty leads to an impossible calculation of the amount of water that is available for the orphanage at a determined time. Due to this reason, further calculations will be made supposing the access to public water is constant (but depending on season) and rain data from 1985 to 2018. This implies a very conservative approach that will lead to consumption policies which, if followed, will assure water availability throughout the whole year.

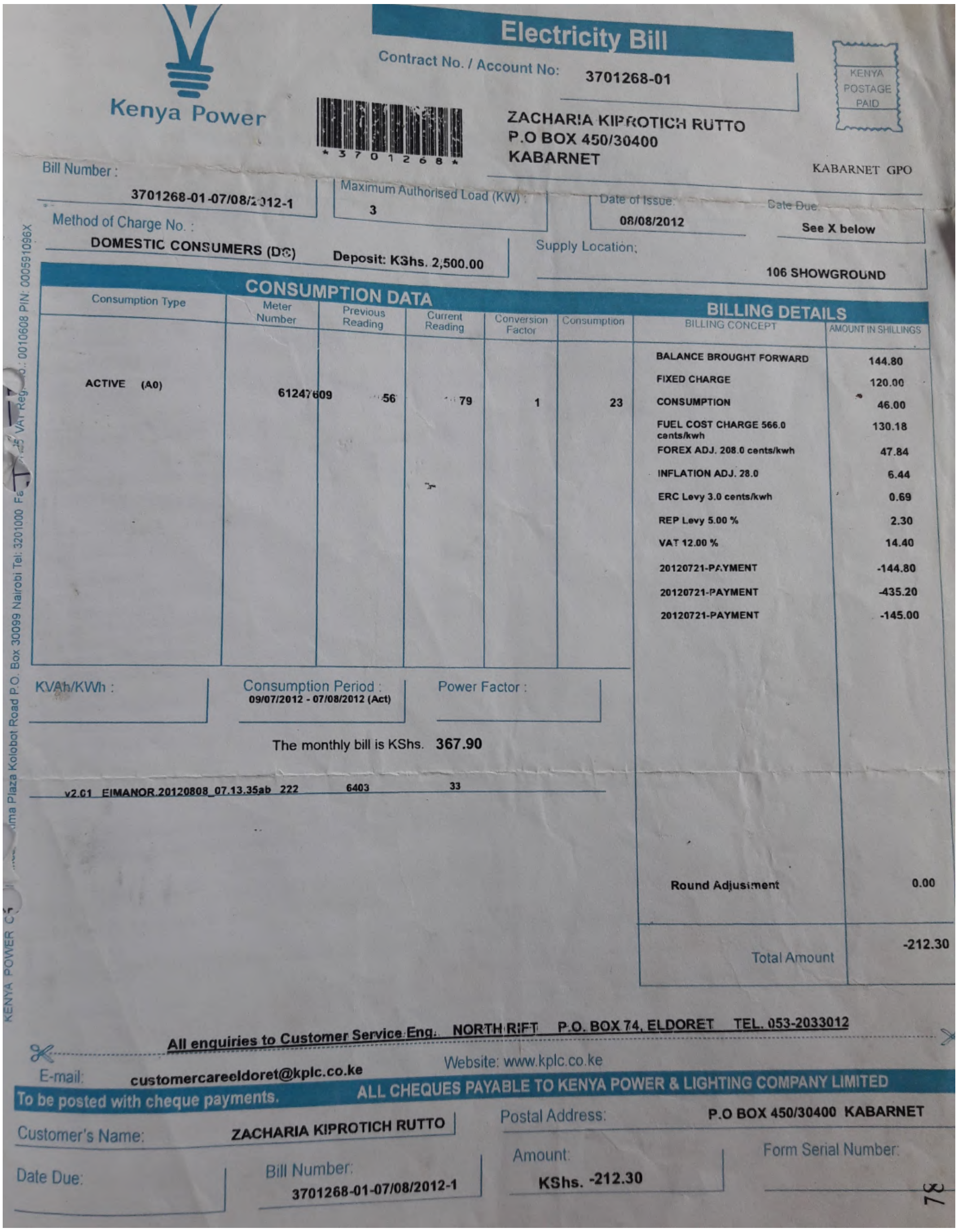
In figure 28, the count meter of Bamba Home can be found. It is situated at the entrance, which means that the uncountable number of leaks and water loss around the whole infrastructure still have to be paid.

Figure 28: Water meter

Regarding electricity, the current infrastructure allows, in principle, for constant electricity availability. Although, due to several problems, oblivious to Bamba management, there is numerous cuts on the electricity delivery. The amount of time without electricity varies between several hours up to two or three days. Usually, during the rain season when there are floods, thunderstorms... electricity shutdowns are more common.

In Figure 29 the electricity bill of the orphanage is shown. Comparing it to a common bill we could be used to see, this is much cheaper than water (367.9 KSH or 3.3€). It has some fixed charges, so as the water bill in Figure 85, but they still much lower than them.

[19] Usually, the vast majority of the pipes that carry the water are not underground but visible. This leads to many leaks due to cars and people going over them every day



Kenya Power

Electricity Bill

Contract No. / Account No: 3701268-01

ZACHARIA KIPROTICH RUTTO
P.O BOX 450/30400
KABARNET

KENYA POSTAGE PAID

KABARNET GPO

Bill Number: 3701268-01-07/08/2012-1

Maximum Authorised Load (KW): 3

Date of Issue: 08/08/2012

Date Due: See X below

Method of Charge No.: DOMESTIC CONSUMERS (DC)

Deposit: KShs. 2,500.00

Supply Location: 106 SHOWGROUND

CONSUMPTION DATA

Consumption Type	Meter Number	Previous Reading	Current Reading	Conversion Factor	Consumption
ACTIVE (A0)	61247609	56	79	1	23

BILLING DETAILS

BILLING CONCEPT	AMOUNT IN SHILLINGS
BALANCE BROUGHT FORWARD	144.80
FIXED CHARGE	120.00
CONSUMPTION	46.00
FUEL COST CHARGE 566.0 cents/kwh	130.18
FOREX ADJ. 208.0 cents/kwh	47.84
INFLATION ADJ. 28.0	6.44
ERC Levy 3.0 cents/kwh	0.69
REP Levy 5.00 %	2.30
VAT 12.00 %	14.40
20120721-PAYMENT	-144.80
20120721-PAYMENT	-435.20
20120721-PAYMENT	-145.00
Round Adjustment	0.00
Total Amount	-212.30

KVAh/KWh:

Consumption Period: 09/07/2012 - 07/08/2012 (Act)

Power Factor:

The monthly bill is KShs. 367.90

v2.01 ELMANOR 20120808_07.13.35ab 222 6403 33

All enquiries to Customer Service Eng. NORTH RIFT P.O. BOX 74, ELDORET TEL. 053-2033012

E-mail: customercareeldoret@kplc.co.ke

Website: www.kplc.co.ke

To be posted with cheque payments. ALL CHEQUES PAYABLE TO KENYA POWER & LIGHTING COMPANY LIMITED

Customer's Name: ZACHARIA KIPROTICH RUTTO

Postal Address: P.O BOX 450/30400 KABARNET

Date Due:

Bill Number: 3701268-01-07/08/2012-1

Amount: KShs. -212.30

Form Serial Number:

Figure 29: Electricity Bill of Bamba Chindren's home

3.3.3 Priority needs

The main problem regarding water is the maximum capacity of their tanks. This is due to the high amount of rain obtained during wet season, that usually overpasses the overall amount that can be stored in the current tanks. The big deposit of 24750 litres is not jet connected to the plastic reservoirs, meaning that usually, when all of them are full the use of water is not limited and the excess of water is lost.

Nevertheless, the maximum time that can be sustained with only the plastic tanks without water is around one week, which means that in the dry season when there might not be rain in full months, the children have to go to the river to get cleaned, so as their clothes in order to keep enough water for drinking and cooking. This will be studied in detail in section 4.

Priority needs are, therefore, to develop a consumption policy according to the amount of rain that can be received and depending on the season. Moreover, another priority need is to connect the main cement tank with the other ones to be able to receive water when they are full and provide water when they are empty.

3.3.3.1 Proposed solutions

The proposed solutions will highly depend on the mathematical tool developed to study rainfall data. One of the main solution that will be proposed is to define the maximum consumption as a function of several parameters that will ensure that the amount of time with no water in the reservoirs gets minimized.

Another solution will be different ways of saving water depending on their use, for example: Toilet flushing limitation, pipe transfer optimization, improving means of collecting water from the roof, re-use of water for specific uses...

3.3.4 Secondary needs

Taking into account that constant electricity availability is not vital, it can be considered a secondary need, nevertheless, it has a high importance when the whole project is brought into action. This is due to the constant need of electricity to feed the pumps with sufficient energy to transport the water from tanks at a lower level to higher tanks.

Therefore, it can be considered a secondary need an alternative mean to feed Bamba with electricity for the common light shutdowns.

3.3.4.1 Proposed solutions

A feasible proposed solution is the installation of solar panels on the roof of the buildings. This is due to the high amount of days when there is numerous hours of sun for several days.

Another solution regarding water is the installation of servo-valves that can be controlled electronically to deliver water from tank to tank depending on their levels to maintain a sufficient level on them to supply water for their uses (showers, kitchen, cleaning...).

This is considered a secondary need because currently, the water transfer from different tanks is made, in the case of lower height, connecting them with a hosepipe making use of gravity, and in case of higher position, with a manual pipe or, punctually, with an electric pump.

4 Study of Rainfall data

In order to perform a professional analysis regarding pluviometric resources, it was necessary to obtain reliable data regarding the amount of rain per day. Fortunately, after long time searching and several interviews, in the Town Hall of Kabarnet, an excel file with these data was provided. In Table 12, attached in the annex this data can be found.

Having this data and several other values personally obtained during residence time in Bamba, a mathematical, numerical and statistical tool was intended to be created using Matlab®.

4.1 Numerical methods for the analysis

In first place, it is necessary to obtain a probability density distribution of rain data along the whole year departing from previously motioned Table 12. Its main purpose is to be able to predict with a certain probability the amount of rain on future years.

4.1.1 Probability distributions

A probability distribution is a function or graph that shows the likelihood of something to happen. For the current water case, it would refer to the amount of litres that are expected to rain with a determined probability on a certain day.

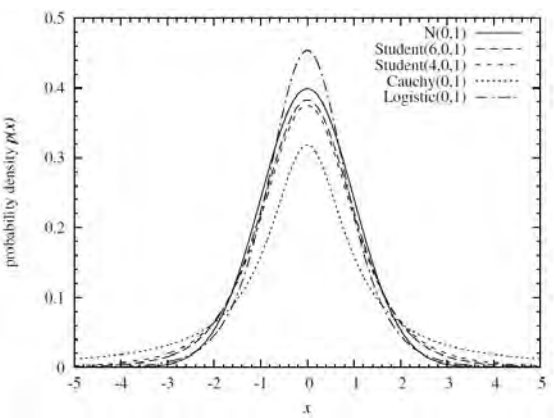
A normal or Gaussian distribution is the most common continuous probability distribution. Calling μ and σ the mean and standard deviation respectively, the probability density function (PSD) can be written as[30]:

$$p(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{1}{2}\left[\frac{x-\mu}{\sigma}\right]^2 \right) \tag{2}$$

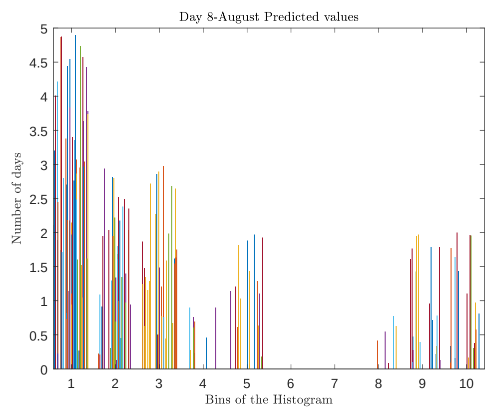
Therefore, the probability of a value to be $\leq x$ or so called Cumulative Distribution Function (CDF) is given by:

$$P(< x) = \int_{-\infty}^{x} p(x')dx' = \frac{1}{2}\,\mathrm{erf}\left(-\frac{1}{\sqrt{2}}\left[\frac{x-\mu}{\sigma}\right] \right) \tag{3}$$

In first place, it was thought that a normal distribution could properly fit the data, nevertheless, while plotting the histograms, it was seen that this approach was not correct. As it can be seen in Figure 30a compared to Figure 30b, several days have rain distributions that do not follow Gaussian distribution, leading to inappropriate values while randomizing values inside the distribution.



(a) Normal distribution shape



(b) Current histogram shape for a random day

Figure 30: Distribution comparison

The main purpose of creating this distribution functions is throwing a dice that randomly picks values of rain flow data inside the graph. Therefore, if the figure does not fit appropriately the actual rain pattern, errors would be made while computing the amount of Litres that can be collected every day.

The first problem was that the vast majority of the days the mean amount of rain was zero or very close to zero, but negative rain is not a possible value, therefore, symmetric distributions are not valid. As a consequence, several other methods were tried in order to be able to characterize the data on a mathematical manner to be able to work with it later on:

Lognormal Distribution[31] was thought to be appropriate because it usually matches positive x-axis naturally approximated normal distributions. Its PDF is:

$$p(x) = \frac{1}{\sqrt{2\pi}\sigma x} \exp\left(-\frac{1}{2}\left[\frac{\log(x)-\mu}{\sigma}\right]^2 \right), \qquad for \quad x > 0 \tag{4}$$

It is important to take into account that in this case, μ and σ are not the mean and standard deviation in the x space but in the log x space. Therefore:

$$Mean\{Lognormal(\mu,\sigma)\} = e^{\mu+\frac{1}{2}\sigma^2}$$
$$Var\{Lognormal(\mu,\sigma)\} = e^{2\mu}e^{\sigma^2}(e^{\sigma^2}-1)$$

And its CDF is:

$$P(<x) \equiv \int_{-\infty}^{x} p(x')dx' = \frac{1}{2}\operatorname{erf}\left(-\frac{1}{\sqrt{2}}\left[\frac{\log(x)-\mu}{\sigma}\right] \right) \tag{5}$$

As a second thought, given that rain values will always be on the right side of the x-axis, an exponential distribution was tried to be fixed to the actual data. In addition, it is a very simple model as there is only one parameter, β that controls its width.

Its PDF is:

$$p(x) = \beta\exp(-\beta x), \qquad for \quad x > 0 \tag{6}$$

And the CDF

$$P(<x) \equiv \int_{0}^{x} p(x')dx' = 1-\exp(-\beta x) \tag{7}$$

In this case, both the mean and standard deviation are $1/\beta$. The median is $\log(2)/\beta$

Moreover, **Chi-Square distribution** was intended to be used because it has a single parameter ν that controls both the location and width of the peak of the graph. Its PDF is:

$$p(\chi^2 d\chi^2) = \frac{1}{2^{\frac{1}{2}\nu}\Gamma(\frac{1}{2}\nu)}\left(\chi^2\right)^{\frac{1}{2}\nu-1}\exp\left(-\frac{1}{2}\chi^2\right)d\chi^2, \qquad for \quad \chi^2 > 0 \tag{8}$$

As before, take into account that:

$$Mean\{Chisquare(\nu)\} = \nu$$
$$Var\{Chisquare(\nu)\} = 2\nu$$

With CDF:

$$P(<\chi^2) \equiv \int_{0}^{\chi^2} p(\chi'^2)d\chi'^2 = P\left(\frac{\nu}{2},\frac{\chi^2}{2}\right) \tag{9}$$

Furtthermore, **Gamma distribution** was attempted. This is because it gives a range of variability from the exponential and the chi-square distributions. Indeed, they are only a special case with $\alpha = 1$(for the exponential case) and, $\alpha = \nu/2$ and $\beta = 1/2$ (For the chi-square case).

Its PDF is:

$$p(x) = \frac{\beta^\alpha}{\Gamma(\alpha)}x^{\alpha-1}e^{-\beta x}, \qquad for \quad x > 0 \tag{10}$$

In this case,

$$Mean\{Gamma(\alpha,\beta)\} = \frac{\alpha}{\beta}$$
$$Var\{Gamma(\alpha,\beta)\} = \frac{\alpha}{\beta^2}$$

Finally and as a last attempt to fit current rain histograms to an specific model, **F-Distribution** was developed:

With a probability density function of:

$$p(F) = \frac{\nu_1^{\frac{1}{2}\nu_1}\nu_2^{\frac{1}{2}\nu_2}}{B(\frac{1}{2}\nu_1,\frac{1}{2}\nu_2})\frac{F^{\frac{1}{2}\nu_1-1}}{(\nu_2+\nu_1 F)^{(\nu_1\nu_2)/2}}, \qquad For \;\; F > 0 \tag{11}$$

Similarly, its mean and variance are given by:

$$Mean\{F(\nu_1,\nu_2)\} = \frac{\nu_2}{\nu_2-2} \qquad For \;\; \nu_2 > 2$$
$$Var\{F(\nu_1,\nu_2)\} = \frac{2\nu_2^2(\nu_1+\nu_2-2)}{\nu_1(\nu_2-2)^2(\nu_2-4)} \qquad For \;\; \nu_2 > 4$$

And the CDF is:

$$P(<x) \equiv \int_0^x p(x')dx' = I_{\nu_1 F/(\nu_2+\nu 1F)}\left(\frac{1}{2}\nu_1,\frac{1}{2}\nu_2\right) \tag{12}$$

While the inverse function, given in terms of the inverse of $I_x(a,b)$on its subscript argument by

$$u \equiv I_p^- 1\left(\frac{1}{2}\nu_1,\frac{1}{2}\nu_2\right) \tag{13}$$
$$x(P) = \frac{\nu_2 u}{\nu_1(1-u)} \tag{14}$$

All previous distributions are shown in Figure 31 to be compared:

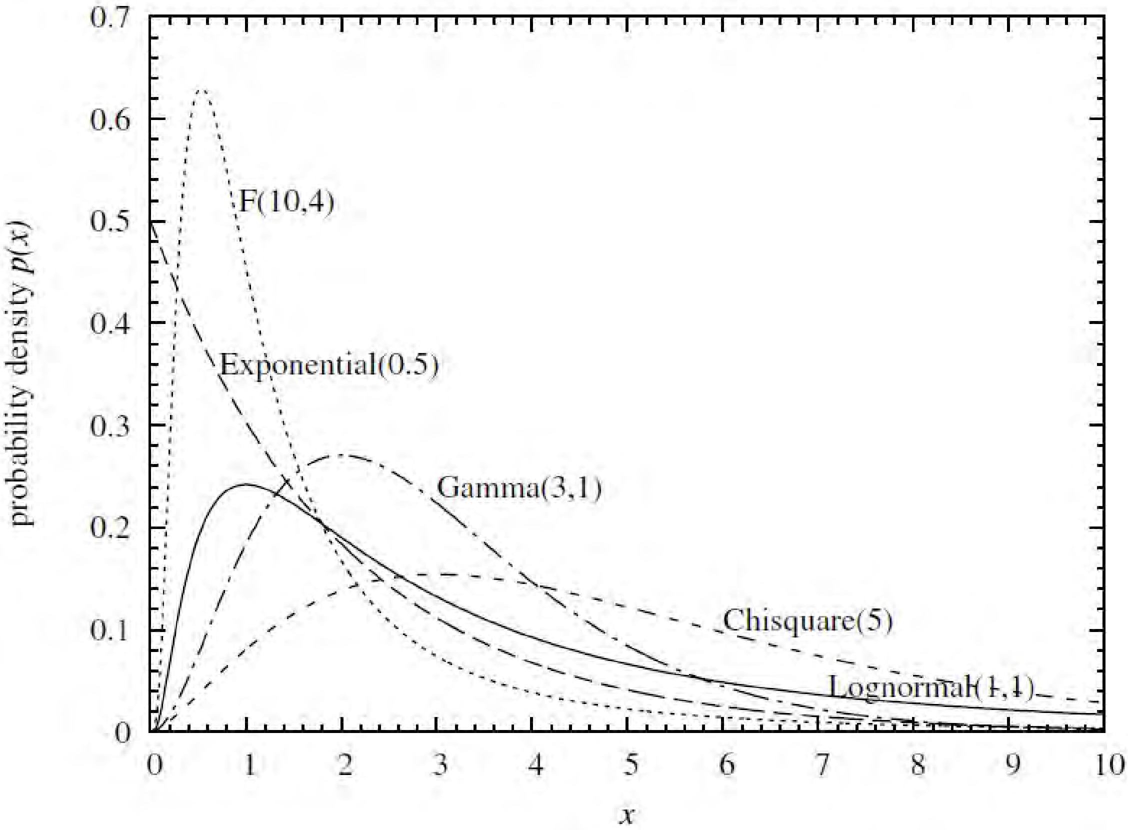


Figure 31: Different distribution models (on the positive axis)

After an exhaustive study of all this methods[20] and the possible manner to apply them on the data of Table 12, it was concluded that none of them could adjust or fit properly enough in order to avoid possible future errors. As it was seen in Figure 30 and could be seen on the rest of the models, the actual pluviometric data behaves on a very random manner, having, for example, several peaks for the same day at different amounts of rain flow, meaning that it is unpredictable by any of the models previously explained.

At this stage different statistical methods or models were being searched in order to find the most appropriate approach for the study of this data.

4.1.2 Monte Carlo Statistical method

Monte Carlo methods are a wide variety of computational algorithms and tools that are intended to obtain results relying on a large number of random samples[32]. In this project, the method will be used in order to create an specific probability distribution shape for each day of the year and, later on, integrate the income and outcome of water in the deposits. This will allow the stochastic modeling of rain data and the study of the most influential variables affecting the results.

In the present, many engineering fields as aeroelasticity, biotechnology, structural dynamics, fluid dynamics... are currently working on a fairly new concept called **Uncertainty Quantification (UQ)**. Given the complexity of the deterministic prediction of the behaviour of some systems, non-deterministic approaches are becoming more and more popular. They are based on assuming key parameters to be stochastic and perform a computational random analysis to reduce the uncertainty of these variables and obtain realistic, high reliability results.

In this project, data from Table 12 is assumed to be a random set of rain values for each day from 1985 up to 2018. Given that non of the probability distributions cited in previous section

[20]All these methods and terminology are subjected to the information extracted from Numerical Recipes book that can be found in[30]

were valid, it was decided to create an specific Probability Distribution numerical Function for each day relying on available data using Monte Carlo Statistical Method.

As a starting point, rain values for each day of the year for all the available years was taken and a histogram was created with it. Figure 32 shows the actual, non variable, histogram for an specific day of the year.

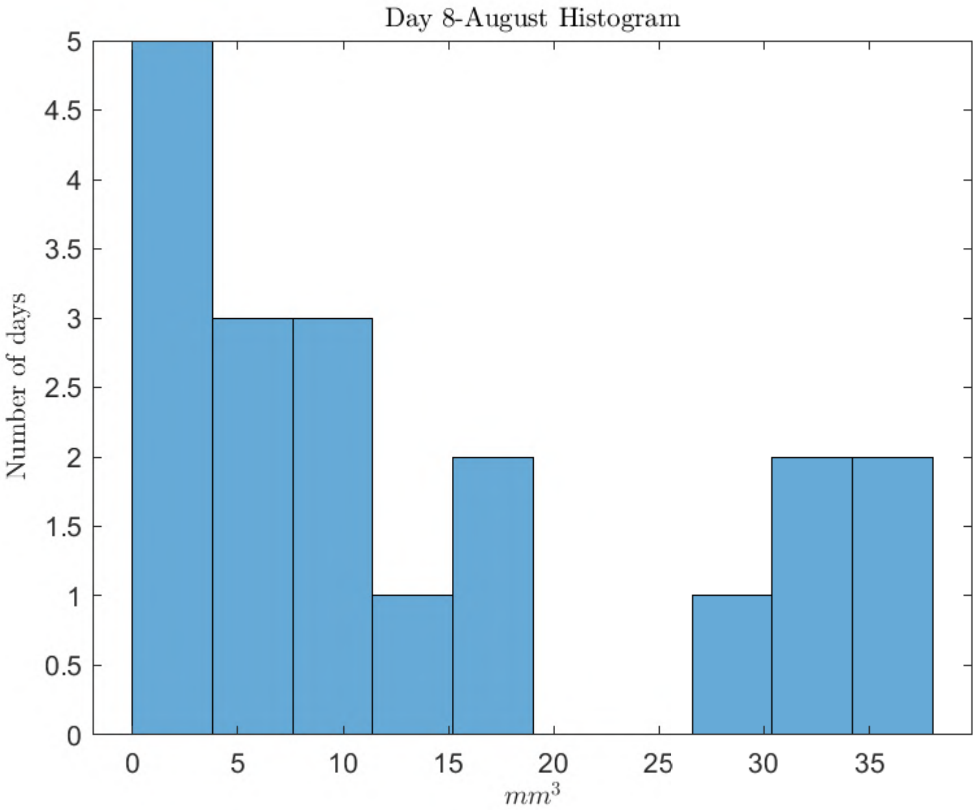


Figure 32: Real histogram of a randomly selected day

Once this histogram is available, an acceptance-rejection method is going to be applied in order to create a reliable distribution based on random numbers (Figure 33).

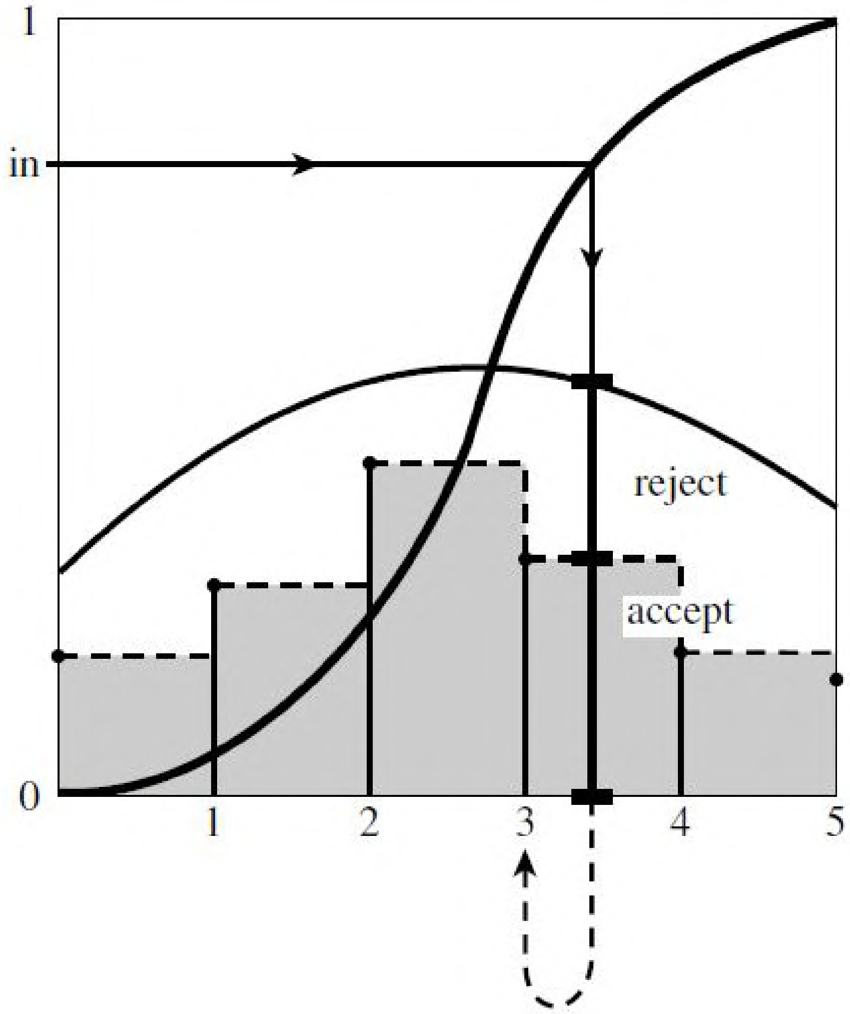


Figure 33: Accept-Reject method for NON rectangular limits [30]

The procedure followed was the following: In first place, and differing from the figure, a rectangle limited by the maximum value of the x and y axis was created (maximum rain and maximum number of days). In second place, random numbers were created embedded in this region. For each of them a logical check is performed: whether it is inside or outside the bins in the histogram. In case it rests outside this region, that point is rejected. On the contrary, if it is inside, it is accepted. This means that the more numbers are chosen for this analysis the more accurate the randomly created histogram will be[21].

[21]The code created for this purpose can be found in Annex 2 (Matlab Code)

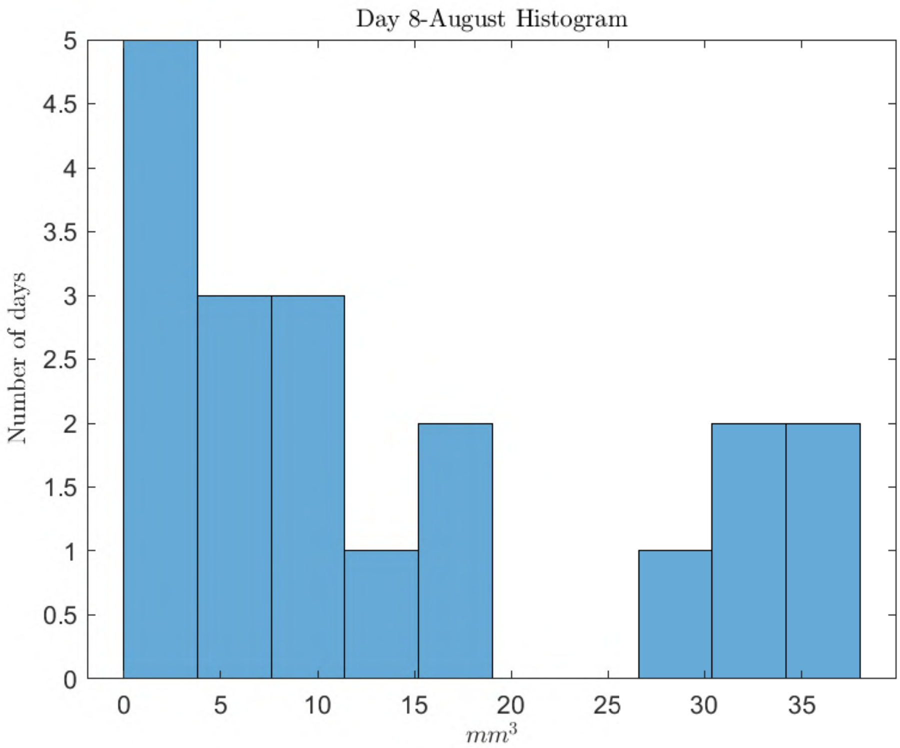


Figure 34: Real histogram of a randomly selected day

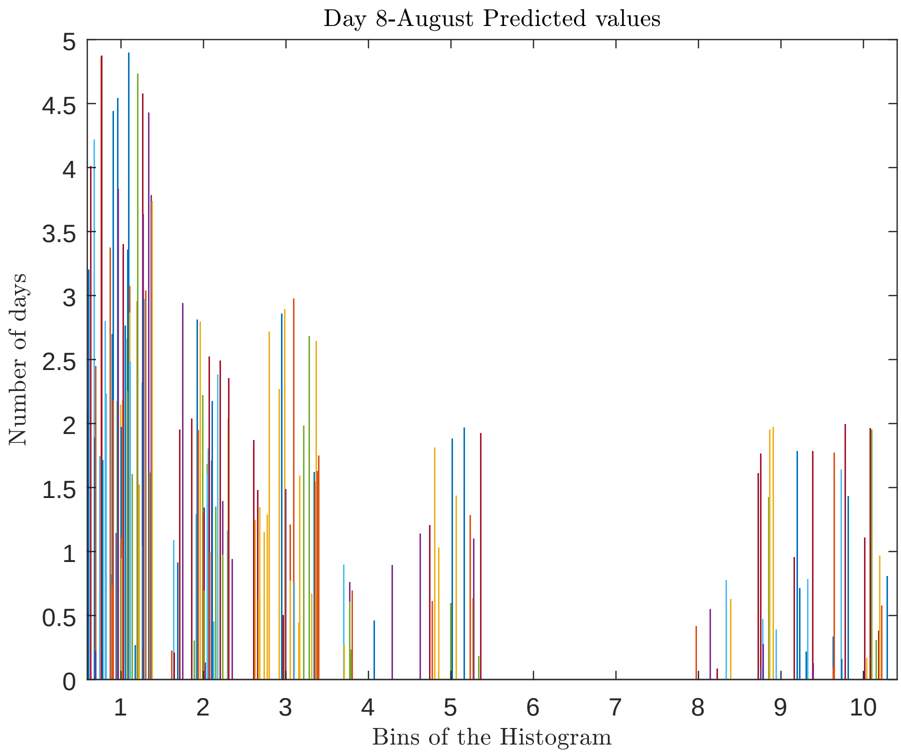


Figure 35: Created histogram with an specific probability distribution using random numbers

As it can be appreciated in Figure 34, when the number of random points used for the accept-reject method is over 500, the created distribution has a very similar shape to the actual histogram of that day (compare Figure 34 and 35). As a consequence, the created model gains reliability with the number of iterations chosen during the computation[22]. Although, Monte-Carlo methods are known to be, specially in this case, very time consuming[33]. Due to this reason, a high performance computer should be used in order to obtain accurate results[23].

4.1.3 Euler-Maruyama stochastical method

Once the amount of rain for a certain day can be found with a reasonable amount of probability, it is time to integrate the volume that can be found in the tanks throughout the whole year.

In order to do so, Euler-Maruyama method[34] is going to be applied. It was named after Leonhard Euler and Gisiro Maruyama arrived to a mathematical procedure that allowed to find a numerical solution of a **Stochastic differential equation (SDE)**.

An SDE has the following shape[35]:

$$dX_t = f(t, X_t)dt + g(t, X_t)dW_t \qquad B.C. : X_0 = x \tag{15}$$

Where f and g are specified functions,$W(t)$ is the Wiener process and $X(t)$ is the solution of the stochastic process.

Wiener process, in this context is often called **Brownian motion process** and accounts for the continuous-time stochastic process in honor of Norbert Wiener[36].

Main characteristics of the Wiener process W_t are:

1. $W_0 = 0$
2. W has independent increments: for every $t > 0$, the future increments $W_{t+u} - W_t, u >= 0$, are independent of the past values $W_s, s < t$
3. W has Gaussian increments: $W_{t+u} - W_t$ is normally distributed with mean 0 and variance u, $W_{t+u} - W_t$
4. W has continuous paths: With probability 1, W_t is continuous in t

In the current project, the f function would refer to the deterministic part, which is the amount of water spent each day in the orphanage (as a function of the number of kids, the number of travellers, the amount spent by each shower, laudry, etc.). In the other hand, the g function refers to the stochastic part, which is the rain income.

Therefore, the solution to Equation 15 satisfies:

$$X_t = X_0 + \int_0^t f(s, X_s)ds + \int_0^t g(s, X_s)dW_s \tag{16}$$

And, for an specific time[37]:

$$X(t_{n+1}) = X(t_n) + \int_{t_n}^{t_{n+1}} f(X(s))ds + \int_{t_n}^{t_{n+1}} g(X(s))dW(s) \tag{17}$$

There are several different methods for solving this expression. Brownian motion is the most appropriate in this case.

Defining:

$$t_n = n \cdot \delta t = n\frac{T}{N} \qquad n = 0, 1, 2, ..., N \tag{18}$$

$$W_{t_{n+1}} = W_{t_n} + \Delta W_n \qquad W_{t_0} = W_0 = 0 \tag{19}$$

And assuming:

[22] This can be chosen in a pop-up window at the start of the execution of the designed matlab program

[23] The workstation of the university was used in order to perform the most time consuming iterative methods and, later on, results were plotted in the personal computer of the writer.

$$\int_{t_n}^{t_{n+1}} g(s, X_s) dW_s \approx g(t_n, X_n)\Delta W_n \tag{20}$$

$$\int_{t_n}^{t_{n+1}} f(s, X_s) ds \approx f(t_n, X_n)\delta t \tag{21}$$

$$\tag{22}$$

We arrive to the **Euler-Maruyama** scheme:

$$X_{n+1} = X_n + f(t_n, X_n)\delta t + g(t_n, X_n)\Delta W_n \tag{23}$$

Where:

$$\delta W_n = W_{t_{n+1}} - W_{t_n} \tag{24}$$

Regarding this approach and given that stochastic data is available only once per day, the assumed time step is 24 hours. Depending on the phenomena that is being studied this should be changed (in biotechnology or structural analysis the time step has to be much smaller). Nevertheless for the given purpose and taking into account that the analysis will be performed for a whole year, a day time step is not inappropriate. Moreover, there is not data for intermediate integration.

Regarding convergence, the numerical solution is considered to be **strongly convergent** if:

$$\lim_{\delta t \to 0} \mathbb{E}\left(\left|X_T - X_T^{\delta t}\right|\right) = 0 \tag{25}$$

And it is **weakly convergent** if:

$$\lim_{\delta t \to 0} \left|\mathbb{E}g(X_T) - \mathbb{E}g(X_T^{\delta t})\right| = 0 \tag{26}$$

Where $\mathbb{E}$ and $\mathbb{E}g$ refer to the error.

Although, in practice the $\mathbb{E}$ is estimated using Monte Carlo simulation, and due to this, zero will never be obtained. It is going to be assumed that the numerical scheme is **strongly convergent with order** γ if:

$$\mathbb{E}\left(\left|X_T - X_T^{\delta t}\right|\right) <= K_T(\delta t)^\gamma \tag{27}$$

Where the constant K_T depends on T and the SDE

On the other hand, the scheme is **weakly convergent with order** γ if:

$$\left|\mathbb{E}g(X_T) - \mathbb{E}g(X_T^{\delta t})\right| <= K_T^g(\delta t)^\gamma \tag{28}$$

Where the constant K_T^g depends on T,g and the SDE.

In practice, what this constant means is that if the numerical solution is convergent with order γ, and the time step is made k times smaller, then the approximated error will be decreased by a factor of k^δ.

In this project, there is an error threshold that can not be minimized. This is because regardless the factor, in order to reduce the error, the time step should be made smaller, and it can not be inferior to one day. For other purposes or projects, given, for example, that the order is 1/2, this would mean that in order to decrease the error 100 times, the time step should be made $100^2 = 10.000$ times smaller. Take into account that the computation time increases with the same factor.

4.2 Water consumption analysis

The water consumed per day in Bamba follows different schemes and can be assumed as a deterministic variable. This is because, even though it depends on many different factors, an specific value can be assumed for certain situations.

Main water sources of consumption are: laundry, flushing, travellers, kitchen and showers. They can be assumed mostly constant over time. Nevertheless, when the remaining amount of water left in the tanks is very low, they usually reduce their biggest expenses by going to the river for laundry and showers. This reduces significantly the daily expense.

The final function that provides with the water consumption along the year has as an input the day of the year (therefore, the number of travellers on that day, which is the only variable), and gives as an output the amount spent the selected day.

5 Developed computational tool

Figure 46 shows the flowchart of the designed matlab program. The software is composed of a main code and several additional functions that will be explained in further detail in Section 5.1

5.1 Functions

Before explaining the main code, it is important to explain and let the reader understand properly what, why and how do the used functions work. Their names are: expense, government, integration and RandomYear[24].

5.1.1 Expense function (consumption analysis)

The expense matlab® function can be found in Annex 2: Expense Function.

Water consumption in Bamba Children's home is a function of several variables that will be listed below[25]:

1. **Laundry:** Assumed to be an average of 400 Litres per day for all the kids and workers plus an additional 30 Litres for each traveller in the orphanage.
2. **House:** Including only cleaning purposes and flushing. Assumed to be an average of 200 litres per day plus an additional 20 Litres for each traveller.
3. **Travellers house:** Includes shower and cleaning of the visitors home. Assumed to be 70 Litres per day per traveller.
4. **Kitchen:** Includes water used for cooking and cleaning the dishes. Assumed to be 200 Litres per day plus 20 additional Litres per traveller.
5. **Shower:** Includes the amount spent by day by the kids and workers of Bamba. (take into account that shower is not taken every day). As an average it is 40 Litres per kid + 60 Litres per worker.
6. **Evaporation:** A simple empirical formula was used in order to calculate the amount of water lost from evaporation[38]:

$$G_s = \Theta \cdot A(x_s - x) \tag{29}$$

Where G_s is the amount of evaporated water in litres per hour, x_s is the maximum humidity ratio of saturated air at the same temperature as the water surface [kg/kg] [kg H_2O in kg Dry Air] and x is the humidity ratio air [kg/kg] [kg H_2O in kg Dry Air][26].

x can be calulated as $^{m_w}/_{m_a}$ where m_w is the mass of water vapor (kg or lb) and m_a is the mass of dry air [kg or lb].

x_s is a function of the temperature. It can be calculated as follows:

$$x_s = 0.62198 \frac{p_{ws}}{p_a - p_{ws}} \tag{30}$$

Where x_s is the maximum saturation humidity ratio of air $[^{kg_{water}}/_{kg_{air}}$ or $^{lb_{water}}/_{lb_{dry_{air}}}]$, p_{ws} is the saturation pressure of water vapor [Pa] and p_a is the atmospheric pressure of moist air [Pa]

Values taken for this variable can be found in Table 3

[24] Please, find attached on Annex 2 (Matlab Code) the full code and functions that will be explained in this section

[25] Data regarding the amount spent per day was calculated using flow meters during the author residence time in the orphanage

[26] Note that the units for Θ do not match because this is an empirical expression.

Temperature (oC)	Water Vapor Saturation Pressure (Pa)	Maximum Saturation Humidity Ratio of Air - x -(kgw/kga)
0	609.9	0.003767
5	870	0.005387
10	1225	0.007612
15	1701	0.01062
20	2333	0.014659
25	3130	0.019826
30	4234	0.027125

Table 3: Maximum specific humidity at some common temperatures

The amount of water lost as evaporation is usually very low along the year. The reason behind it is the variable v, which is the air speed on the surface in contact with the water. Given that all of the tanks are closed this variable assumes very low value. Moreover, the subtraction $x_s - x$ in expression 29 assumes small amounts as the maximum saturation humidity ratio of air inside the tank is very close to the actual humidity ratio. The problem of evaporation becomes of a greater importance when the accumulation of water is made open-air, leading to high convection on the surface of the liquid and, therefore, more loss.

7. **Leaking:** In order to calculate the amount of water lost from leaking (which is a very common phenomena, not only in a small scale but also in the main pipes of the city), the procedure followed was the following. Flow meters were installed in the output of the deposits and the amount of water for previously mentioned purposes was added using buckets. This was a very tedious process that only lasted three days. Nevertheless, it was enough time for two of the tanks to empty out, which gave reliable data of the amount of water that could be lost through leaking. Measurements gave an average of 2.3% of the total amount of water going through the pipes. This value is usually very small compared with the amount of water going in or out from the tanks (2 to 5 litres per day). Nonetheless, adding up this losses through the whole year the quantity becomes more important. It is therefore important to keep track of them and perform a proper maintenance in order to minimize its impact.

Once all the sources of consumption are known, the only unknown left is the number of travellers living in Bamba each day. This information was provided by the NGO manager:

- December to February: **3** people
- March to June: **2** people
- July and August: **14** people
- September to November: **6** people

Finally, the total consumption per day was calculated as follows:

$$C_{Total} = C_{Laundry} + C_{house} + C_{Travellers} + C_{Kitchen} + C_{Shower} + C_{Evaporation} + C_{Leaking} \quad (31)$$

Nonetheless, it is common sense that, whenever the tanks are emptying[27], consumption is reduced in order to increase the amount of days before they are completely finished. Therefore, the expense function includes a condition which implies that, when the amount of water left is less than a certain amount, a water saving policy is introduced.

According to the author's experience, this water saving policy includes going to the river for washing the clothes and having showers. Usually the travellers are not forced to do it, but it is their moral right to, at least, reduce as much as possible their consumption.

[27] In principle, this amount was assumed to be 5500 L, nevertheless, changing this value leads to notorious changes on the overall amount of water throughout the year.

The expression for the previous assumptions is the following:

$$C_{Saving} = 0.5 \cdot C_{House} + 0.75 \cdot C_{Travellers} + 0.75 \cdot C_{Kitchen} + C_{Evaporation} + C_{Leaking} \quad (32)$$

Finally, the calculated amount of water is saved into a global variable in order to visualize later on how much water is spent every day. This allows making an analysis on how many days they have to implement the saving consumption policy per year.

The **inputs** for this function are, therefore, the month and day of the year in order to be able to calculate the number of travellers in the orphanage, and the volume of water available in the tanks the previous day. The only **output** is a single variable with the amount of water spent that day.

5.1.2 Government function (input water from government)

Water Resources Authorities of Baringo County provide several houses with the access to water. Nevertheless, it is not continuous as it could be thought. There is a timetable which can be found in Figure 84 in Annex 1 (Interviews). After several dialogues with local inhabitants and authorities and some personal research, it was found that these agenda is usually not followed. Moreover, as the water arrives by the action of gravity, depending on the height of the pipe connection with respect to the main deposit of the city, the pressure changes significantly. This means that, as water rationing depends on time, those houses with more height difference get a bigger flow rate, traduced as even 70% more Litres than other places.

For the case of Bamba, whenever the water is open for them, they receive it for a maximum time of eight hours, which traduces, taking into account their height and corresponding pressure, to an approximate conservative amount of 5000 L.

During the rain season, timetable in Figure 84 is usually followed, which means that they get water on alternative days (four days per week).

Although, during the long dry season, the timetable is not followed[28]. This means that they only receive 6000 L two days per week (in some critical situations is even worse and water is only obtained once per week).

Government function, therefore, takes as **input** the day and month of the year. In first place, it calculates whether it is rain season or not, and as a function of that, follows the timetable in order to provide with an **output**[29] of 6000 Litres.

5.1.3 Integration function (Monte Carlo statistical method)

Please, find attached the code for this function in Annex 2 (Integration Function).

As a first step, this function loads the data from Table 12[30].

Its only **input** is the day and month of the year. For each day, it calculates the ratio of days that rain was different than zero with respect to the total number of years.

This is performed in order to randomly determine if the selected day has rained or not via de following expression:

$$rain = rand() < \frac{N_r}{N_y} \quad (33)$$

Where rand() creates a random number between 0 and 1, N_r is the number of years that it has rained on that day and and N_y is the total number of years available in the data. Therefore, rain, is a logical value that becomes TRUE whenever the random number (taken as percentage of probability) is lower than the actual percentage of probability of rain. This imposes the condition of supposing zero rain (FALSE) whenever this random number takes a bigger value than the actual probability percentage of rain that day.

Let's suppose it only rained 5 out of 35 years on the current selected day, this would mean that the program will only assume that it rained this day if the random value from 0 to 1 is lower than

[28] According to information provided by the workers that can be found in Annex 1 (Interviews)

[29] In the program this output variable is called Gov, as it can be checked in Annex 2 (Government function)

[30] This table can be found in the Appendix in table 12 and the data was provided by the local authorities of the city of Kabarnet

$5/35 = 0.1429$. In the case this condition does not hold ($rain = FALSE$), the **output** of that day in mm/m^2 will be zero and the program would exit the function.

In the case the condition does hold ($rain = TRUE$), a histogram with a pre-selected (by the user) number of bins will be created (but not displayed). This histogram takes as input the amount or rain for the selected day each from the 38 years of data. Following, the accept-reject method will take place. To this end, it is necessary to establish the limits of this histogram in both the x-axis and y-axis. This means creating an imaginary rectangle where random numbers will be embedded. Later on, the software will run a For loop with a maximum number of iterations selected by the user at the start of the execution. For each of this iterations, a random position X and Y will be created and a check is implemented. If the randomized position is above the real histogram, that value is rejected and the loop will keep iterating until finding one. This procedure assures having a very similar rain probability distribution, different for each day, on the long term.

If the maximum number of iterations is achieved and none of the values has been accepted the following error will arise: *"Not able to find a rain value under the histogram for the selected number of iterations"* and the program will stop.

Concluding, this function needs as an **input** the day and month of the year and offers as an **output** the most probable amount of rain in $[mm/m^2]$

5.1.4 RandomYear function (Euler-Maruyama integration)

Once the software is able to calculate the amount of rain for every single day of the year, it is time to integrate along the whole year the stochastic and deterministic parts as a whole. Euler-Maruyama method has been used as explained in Section 4.1.3.

In first place, it is necessary to find the maximum capacity of all the deposits together: girls tank (2000 L), boys tank (2300 L), travellers tank (5000 L), home tank (5000 L), kitchen tank (2300 L), cement tank (24.750 L). The total amount of water that can be stored is then **41.350 L**.

In second place, a loop for each day of the year is performed. At every iteration, several calculations and checks are performed in the following order:

1. Obtain the randomized pluviometric data $[mm/m^2]$ for the selected day, the water received by the government [L] and the corresponding consumption of that day [L].

2. Check if previous day volume is lower or equal to zero. In case this is true, set volume equal to zero and add up the amount rained on the current day, the water received by the government and subtract the expenses. In case this is false, add up previous day volume plus the incomes minus the outcomes from today[31]. Take into account that in order to calculate the amount of rain received into the tanks from the roof the following expression was used:

$$Volume[L] = \frac{mm}{m^2} \cdot S_{roof} \cdot K \tag{34}$$

   Where S_{roof} is the surface of the roof; $233.5[m^2]$ and K is a constant to account for the water losses while carrying it from the roof to the tanks using gutters and PVC pipes. This value was assumed to be 0.92, as more or less 8% of the water was lost (via empirical observations and information from the workers of the NGO).

3. Check if current day volume is higher than the maximum amount that can be stored on the tanks. If this condition does hold, then set current day volume to the maximum value. If this condition does not hold, simply leave the obtained value.

Finally, summarizing, this function takes as only **input** the initial volume at the start of the year and provides as an **output** a [1x366] matrix with the amount of water available in the tanks (taken as a whole) each day. There is 366 columns because the first position accounts for the initial value, which does not necessarily have to be the same value of the first of January, as there could be rain, consumption... The purpose of this extra position was also performing a long term analysis in which, the last day of previous year is the initial volume datum for the current year calculation.

[31] From now on, the **incomes** will be the rain and the government water and the **outcome** will be the consumption (already including leaking, evaporation...)

5.2 Main Tool

The Main Tool is the principal and most important part of this project. It is responsible for the correct joint of the previous sections together and the calculation and plotting of the amount of water available on the tanks[32].

In order to properly understand the procedure and steps followed through the code, please, refer to the flowchart on Figure 46.

As soon as the program is executed, the following menu will appear:

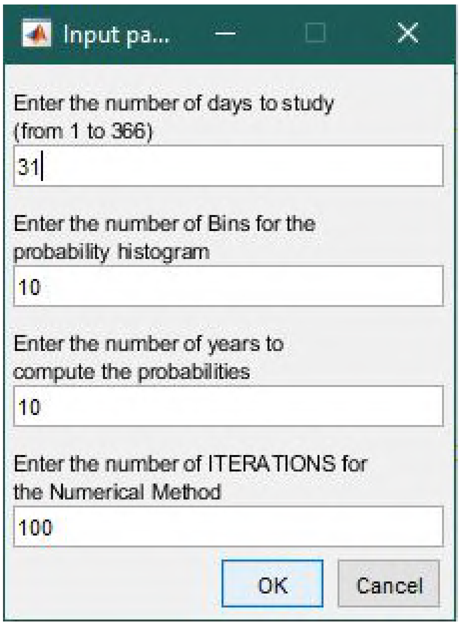


Figure 36: Menu for the user to select relevant values

The user should select at this point the following values:

- **Number of days to study:** In case the only interest is to run the program in a certain section of the year, the user can select a number between 1 and 366 and the program will stop executing at that point. Remember that the last number is 366 because the first number is 0, referring to the initial volume on the tanks at the start of the year (Boundary condition for integration purposes that can be changed to the user's wish).

- **Number of bins for the histogram:** In first place take into account that, even though none of the histogram is displayed during the execution of the code, there are two important and <u>different</u> histograms. The **first** of them is the one corresponding to the amount of days that it has rained a certain quantity (taken from actual data in Table 12). There is a different one for each day of the year and, as an example, take Figure 32. The **second** one corresponds to the probability of having a certain amount of water on an specific day. This histogram depends on the next variable to be chosen on the menu; the number of years to compute the probability. If the number selected is big (50-100), even though the execution time will become significantly higher, the results will be more accurate. This is because the program will calculate the variation of water in the deposits throughout a random year several times and then, obtain the most probable values depending on these data.

- **Number of years to compute the probability:** As previously mentioned, this variable is very time-sensitive, but, the more years are available to compute the probabilities, the higher the accuracy of the results will be.

[32] Bare in mind that even though there are several tanks at different heights as seen on Section 3.3.2, the volume is taken as a whole, as the sum in each of them. In further sections the problem of distributing the water in-between them will be tackled

- **Number of iterations of the numerical method:** The number of iterations of the numerical method refers to the maximum number of random points the program will throw in the first histogram for the accept-reject method to find a rain value under the graph (meaning, with the same probability distribution as the real one obtained from Table 12). The program has been tested countless times and, it seems that the predefined value from the author is enough in order not to display an error for not finding an accepted value on the graph. Nevertheless, in the rare case of this error happening, please, increase the value to 200.

Once the values in the menu have been set, the program will start executing and the following time bar will appear:

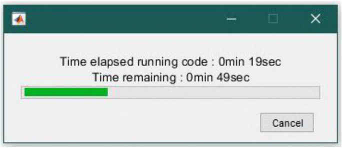


Figure 37: Progress bar of the time remaining for the code to finish executing

This progress bar refers only to the time taken and remaining for obtaining the necessary values for the future plots. Although, as the program seemed to take usually more time to plot the results than executing, the following bar will appear next:

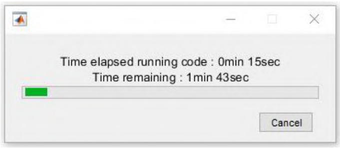


Figure 38: Progress bar of the time remaining for the code to finish plotting

Giving information about the time remaining for the code to completely finish.

As it can be seen on the Flowchart, the first step is checking if the total amount of years to perform the probability (selected by the user) is reached. If it is not, the program will perform a loop for each day of a random year and call the function RandomYear in order to obtain the Volume on the tanks each day. This function calls additionally the expense, government and integration functions in order to calculate the incoming and outgoing Litres. Integration is the most complex one, as it could be seen on Section 5.1.3. As mentioned before, accept-reject method is carried away in order to always obtain values inside a probability distribution according to the studied day. For that purpose, random numbers inside the rectangle limited by maximum X and Y axis of the histogram are created until one is below the real histogram. Take into account that this value will only be used if the probability of having something different to zero rain is sufficiently high (higher than the real probability according to the data in Table 12).

Once all the incomes and outcomes for an specific day are known, Euler-Maruyama method is applied to integrate the volume along the year, keeping into account that volume can not be negative or higher than the maximum capacity of all the tanks together.

Once the software has performed the selected number of random years by the user, a probability study is implemented. An array is created with the amount of water and its corresponding probability, therefore having a [2x Number of bins selected x Number of days selected][33] three dimensional matrix. This is the final and most important result from the program.

The first thought was to plot a three dimensional surface in which the X and Y axis represented the amount of water in the deposits in Litres and the days of the year respectively. The Z axis would be the probability of having that amount of water. An example of the desired shape that was being looked for is Figure 39:

[33] This matrix is called *prob_vol_dia* in the code and its construction method can be seen in Annex 2:Main Tool

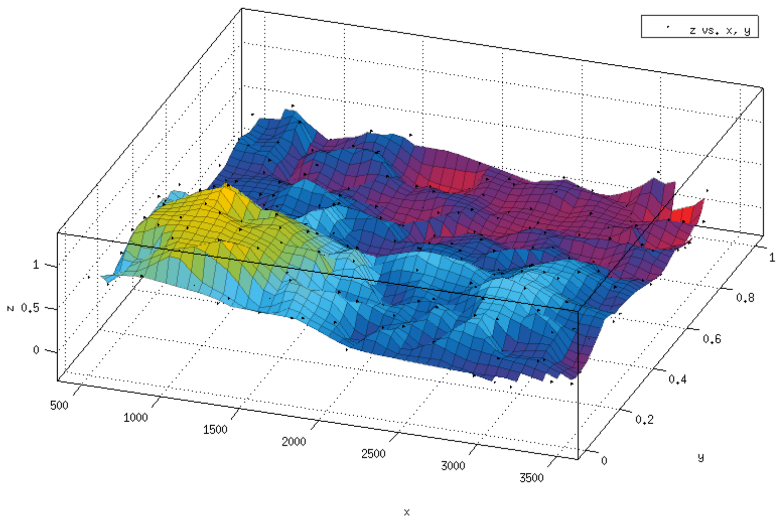


Figure 39: Desired representation of the resultant 3D matrix

Nevertheless, the result was nothing similar. Moreover, there was no continuity from previous to following points, leading to a very unclear image of the physical phenomena that wanted to be shown. The problem was that every single day has different amount of water with different probabilities, leading to discontinuities on the surface. It might not be intuitive, but it was found that some days, the probability of having higher amounts of rain was bigger than having low amounts. Usually, it is the contrary, obviously, there is only few years with peaks on certain days, leading to lower probabilities for the studied day.

Figures 40 and 41 show the actual result of plotting in 3D the results from this matrix.

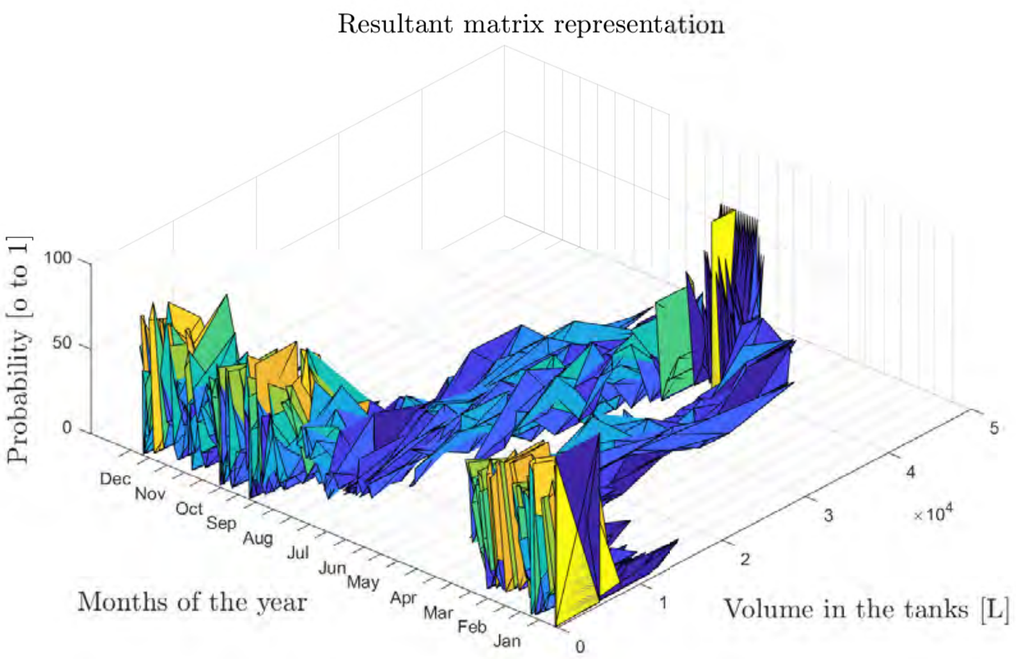


Figure 40: Real representation of the 3D matrix

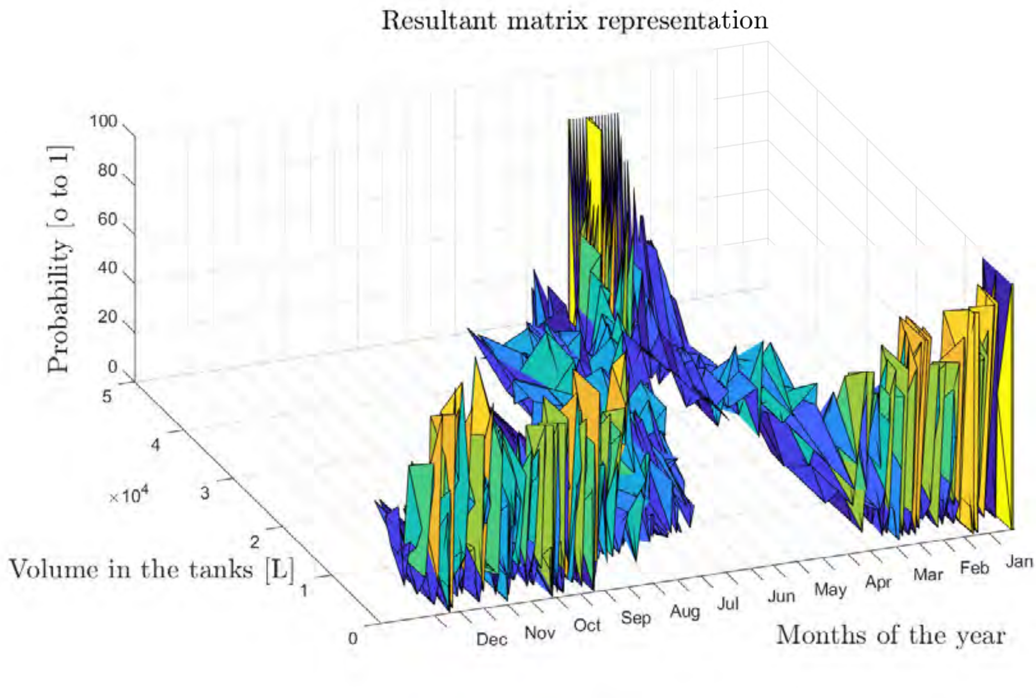


Figure 41: Real representation of the 3D matrix

As it can be appreciated[34], close to the first days of the year, the probability of having zero or nearly zero water on the deposits is very high (taking into account current boundary condition of no initial value). Next peaks of high probability are around the rain season when most of the years the deposits get completely full. The rest of the surface is very irregular and hard to visualize, this is why a representation on 2D was more appropriate.

Once the code has finished running, the following plots will appear:

[34]This is just an example matrix but, as random numbers are used to perform the numerical methods, the results will always be different (but very similar, as the probability distribution followed is the same)

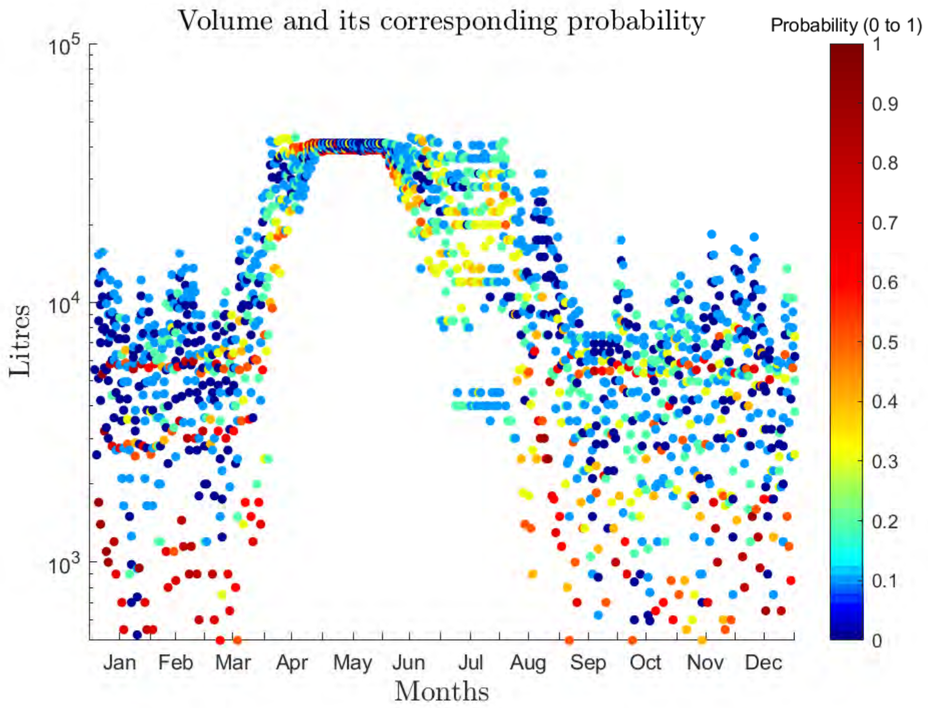


Figure 42: Volume VS Time with probabilities

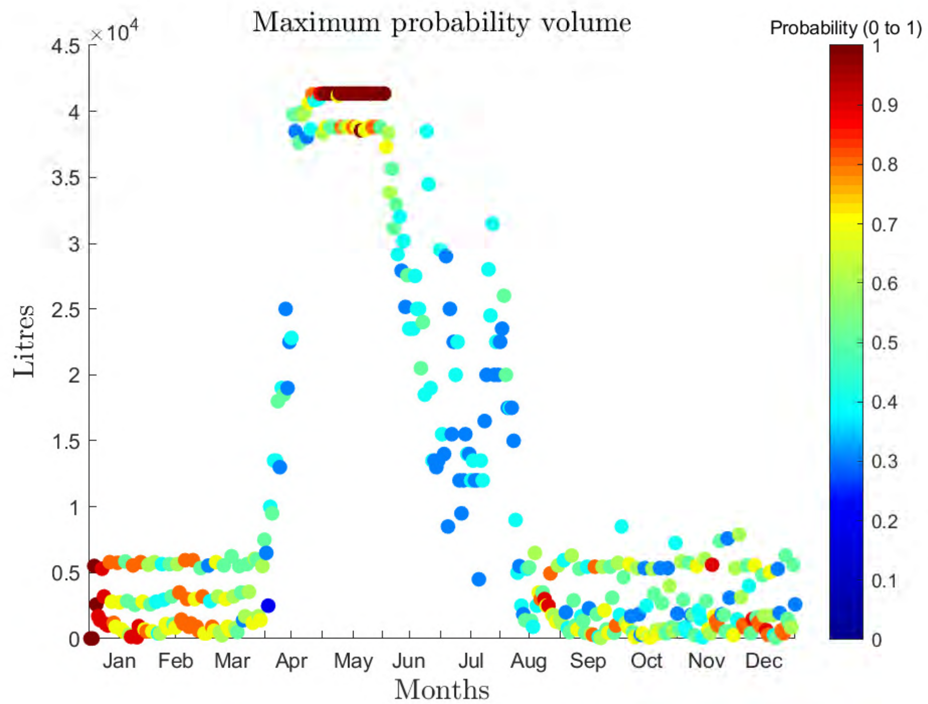


Figure 43: Maximum volume probability for each day

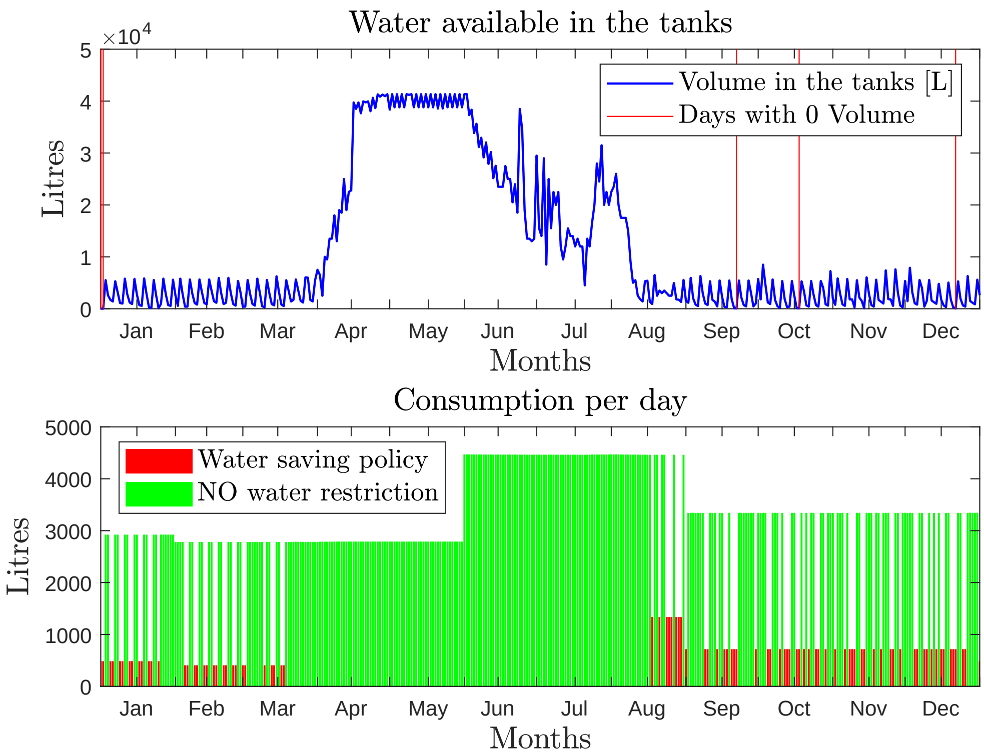


Figure 44: Consumption each day compared to available volume

Figure 42 shows a top view of Figure 40, where it is easier to visualize the range of values for the Volume available in the tanks and their corresponding probability. The number of points for each day can be changed using menu in Figure 36: Number of bins for the histogram.

The colors of each point show the probability of having the amount of water on the Y axis. Values go from 0 to 1, as it can be seen in the color-bar[35].

This graph was still not sufficiently intuitive, therefore, the maximum probability value for each day was selected and plotted in Figure 43.

This is the most important chart of this project, as it shows with a reasonable amount of reliability the volume of water that will be available on a certain day on the following years[36].

Finally, in order to be able to properly recognize when the water-saving consumption policy was being used, Figure 44 plots together the maximum probability volume each day with the consumption each day. This helps comprehending when and why consumption should be drastically reduced in order to achieve the main goal of the project: **Being able to remain the whole year without running out of water.** Moreover, red and green colors show the days when the consumption policy had or did not have to be implemented, therefore making it clearer when they have to make the effort of going to the river for laundry and shower.

Additionally, the program will display a message at the end informing about the amount of days that the consumption restriction had to be applied and the days that they have been left without water. See Figure 45:

[35]The layout of colors has been changed manually in order to make it easier for the reader to visualize and understand the graph.

[36]Please, remember that the statistical and numerical methods used for the analysis do not take into account tendencies, which, as it was seen on Section 3.1, have an important influence.

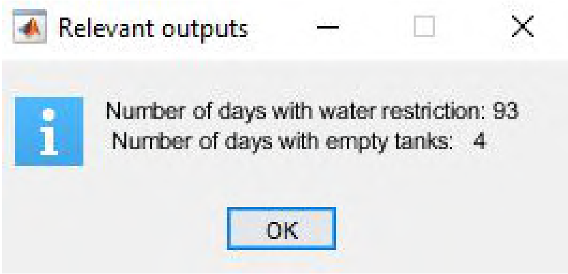


Figure 45: Relevant information

There are many different consumption values depending on the day of the year, this is mainly due to the amount of travellers on the orphanage and the remaining amount of water at the end of the day. As a first approach, it is appreciated that the only moment during which they will be able to have a normal consumption rate (with no limitations) is during and after the rain season; usually, from day 156 to 241, which corresponds to the months of May, June and July. Moreover, the amount received by the government is much less during dry season, leaving no other option than applying a more restrictive consumption policy if our goal is not to be left without water.

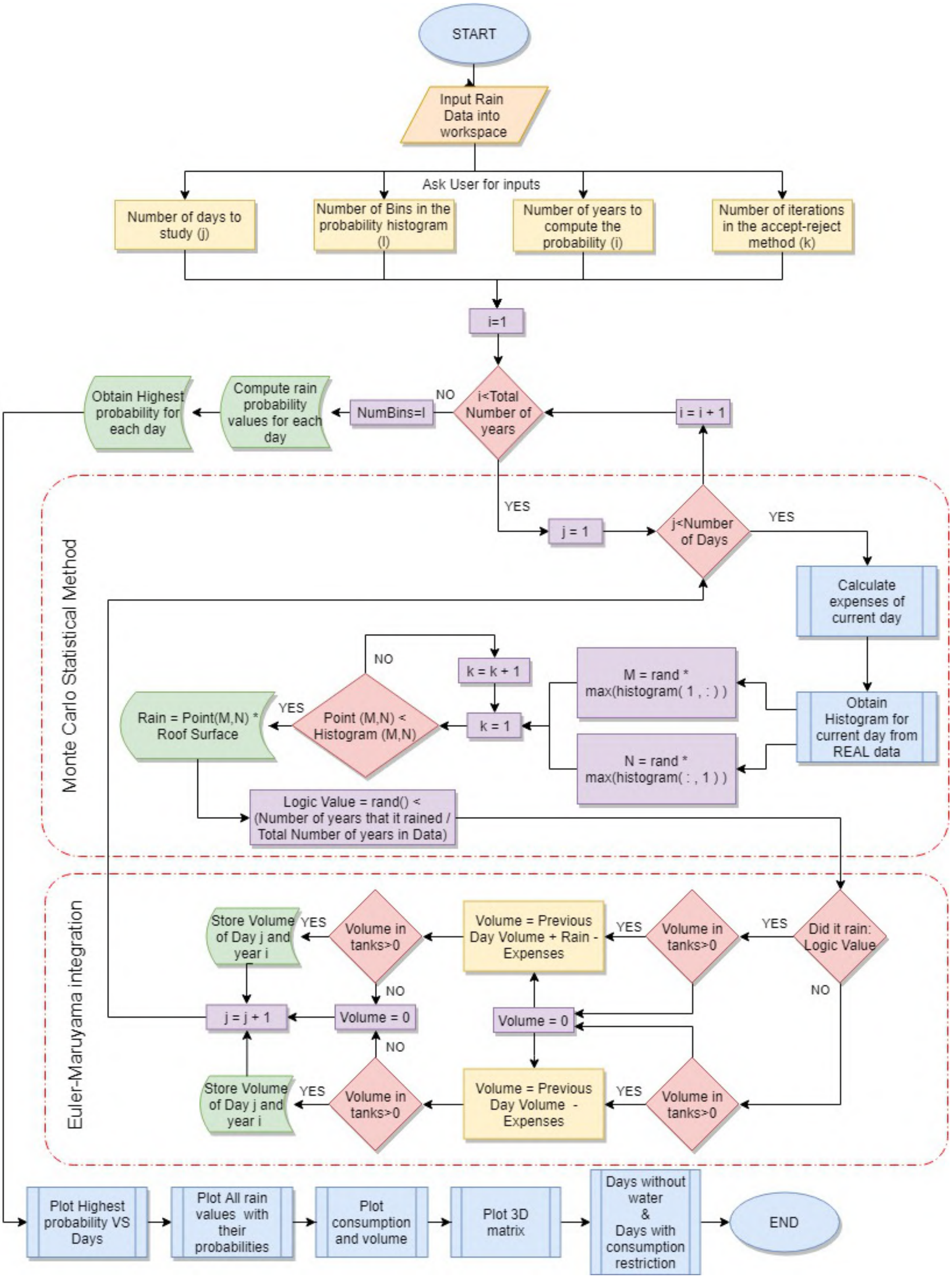


Figure 46: Flowchart of the matlab code

6 Data results and conclusions

The developed software offers a wide range of possibilities regarding water resources management, not only for Bamba children's home but also for any organization or congregation of people. The only thing needed is a pluviometric registry of at least 20 years to make the results consistent.

Changing several variables, the influence onto the final overall volume can be easily seen with the designed tool.

In the following sections, examples will be exposed, nevertheless, we encourage the reader to execute and play with the program in order to discover all its functionalities. As stated at the start of the project, the limits are on the imagination of the user. There are countless possible purposes, as agricultural, social, political, economical, etc.

6.1 Scenarios

In order to show some of the most relevant variables that notoriously affect the results, a different code was implemented, based on the explained one, but modifying certain parameters and plotting the results together for further comparison [37].

Even though a selected variable will be changed in every case study, the rest of them will remain constant, therefore it is appropriate to first state their values:

- Number of days: 366
- Number of Bins: 10
- Number of years: 50
- Number of iterations: 100
- Amount received by the government: 5000 L
- Amount spent per traveller per day : 200 L
- Water threshold for restrictions: 2000 L

6.1.1 Government income variation

Given the amount of people and, therefore, consumption of water per day, Bamba is really dependant on the amount and periodicity of water reception from the government. In the current analysis, four different scenarios will be analyzed regarding the amount of water received each time they do receive water[38].

- **1000 Litres:** Very unrealistic income, nevertheless, in dangerously dry years, at some stages of the months of January, February... the workers of the orphanage have records of receiving only 1000 to 2000 litres only twice a week.
- **3000 Litres:** In this case, even though it is not common, in some lack of water situations, the government is not able to provide with more than this amount.
- **5000 Litres:** This is the most frequent income. Even when there is super-habit in the water city tanks, they do not usually get more than 5000 litres.
- **7000 Litres:** Very optimistic and unrealistic income, but important to see its influence with respect to the other cases and analyze whether this 2000 Litres increase would make or not a really notorious change.

[37] This code takes at least four times longer to be executed, as the four different cases have to be integrated separately and then plotted.

[38] Remember that even though there is a calendar according to which they should receive water three times a week, during the rain season they only get it one or two. In this analysis, the days they receive water are invariant, the variable is the amount.

Please, refer to Section 5.1.2 in order to properly know where and how to change this value. In Annex 2: Government function, this parameter is called "Gov".

The analysis provides with the following figure:

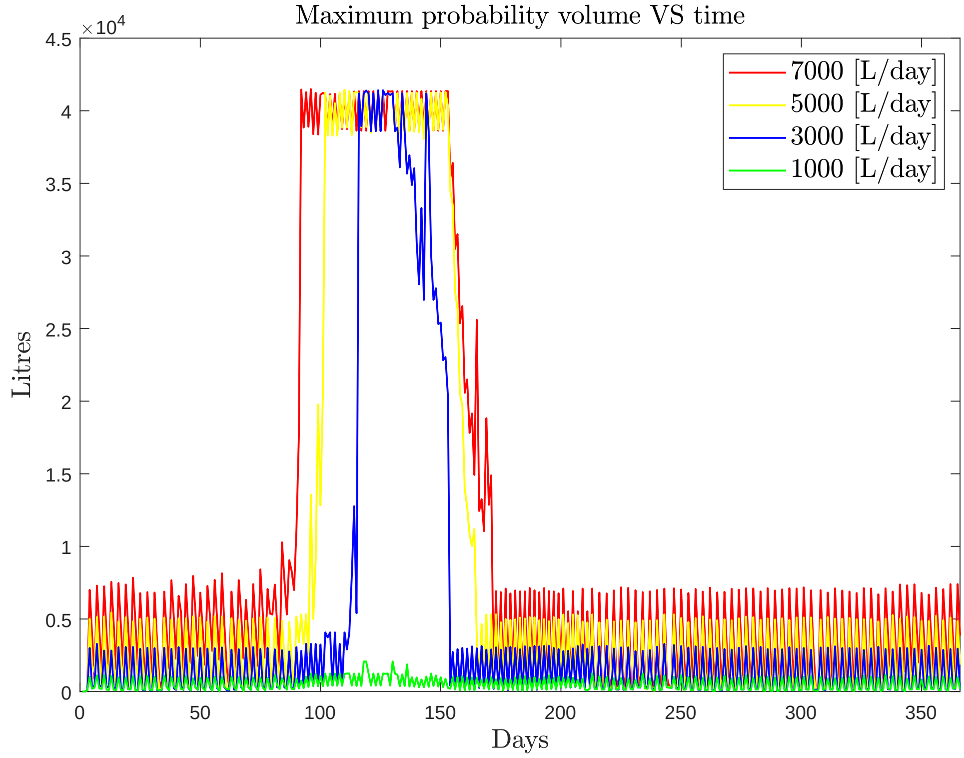


Figure 47: Government input influence comparison

The first thing that one might think while looking at Figure 47 is why the green line, referring to the most pessimistic case, never grows during the rain season. The answer is really simple: given that they have a minimum consumption, even when water saving policy is being applied, if the water receiver by the government is not some higher to 1000 L, there is not any possible chance to accumulate water as rain water is less than their actual consumption.

The second fact that is observed is that there is a frequency oscillation , with maximum peaks at the amount that the government provides, therefore, increasing this value increases the amplitude of this oscillation. Nevertheless, the minimum values of this vibrations are really close to zero for all cases.

Finally, and most important, there is an evident influence on the amount of time they can remain with the deposits mostly full before dropping down after the rain season. For the case of the blue line (3000 L), this time is around 40 days. For the case of the yellow line (5000 L), 70 days and the red line (7000 L), nearly 100 days.

Concluding, once the minimum value from which they can start storing water is surpassed, increasing by 2000 L the amount received each day, increases by approximately one month the time they store water in the deposits.

6.1.2 Volume threshold for water saving policy

A reasonable, easy and effective manner of properly controlling water consumption is setting a limit under which, a water saving policy has to be applied. In some way, this is already being applied by them but with much less anticipation to future predicted volume values. Therefore, it becomes very advantageous approximately knowing how much can be spent a certain day and its direct consequence on the medium-long term. As explained previously in Section 5.1.1, the main sources of consumption that are eliminated during a water restriction policy is shower and laundry. Nonetheless, the idea is now directed towards setting a threshold minimum value to implement this constraint. Four different situations were studied and plotted together for comparison:

- **1000 L:** Clearly low and unrealistic value to start the water saving policy. This is because 1000 L can be spent in less than one day and, if there is no income in the next day (which could be really normal) they run out of water really quickly.
- **3000 L:** Currently, in Bamba, when the water level goes below this value, they start saving water in the laundry and showers.
- **6000 L:** Conservative value that was chosen by them at some stages, i.e. dry year, low income from the city water, high amount of visitors to Bamba...
- **10000 L:** Unrealistic and exaggerated value in order to visualize the impact of drastically increasing this threshold.

Please, refer to Section 5.1.1 in order to properly know where and how to change this value. In Annex 2: Consumption function, this parameter is called "threshold".

Results for previously stated variables is shown in the following graph:

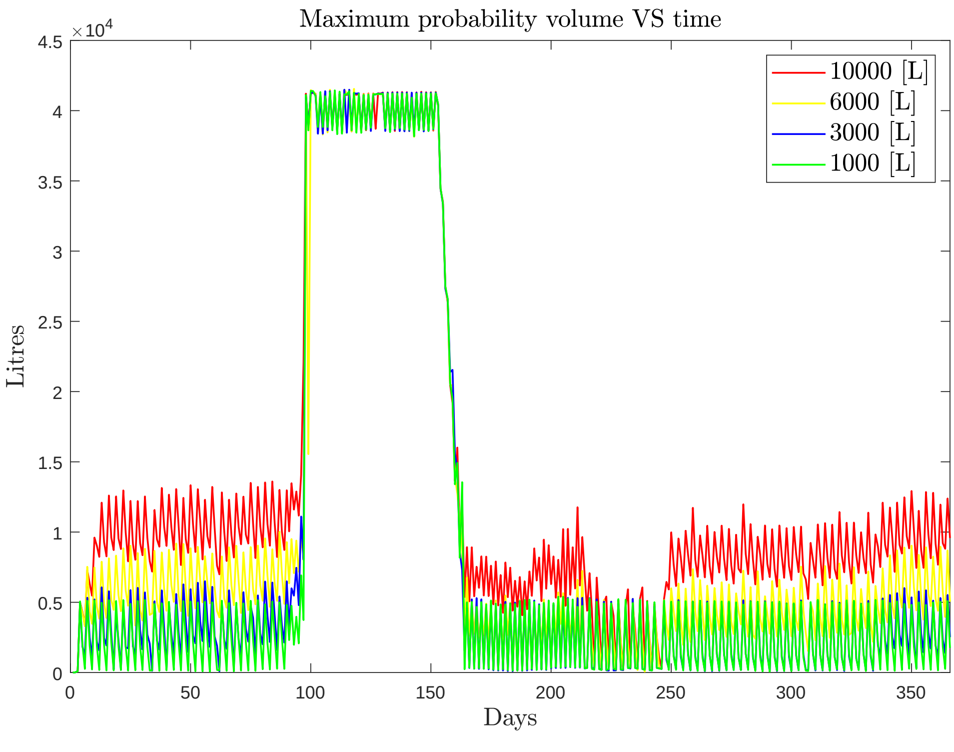


Figure 48: Water threshold minimum influence comparison

In this case, the oscillations remain the same both in amplitude and frequency, although, the height over the zero line is notoriously changed. This was an expected result, as it is being imposed that below certain values their consumption gets reduced. Indeed, the mean value of the vibrations remains always really close to the water saving threshold selected.

Regarding the time the deposits are full, it remains constant for all cases.

Finally, it should be taken into account that even with a very strict and unrealistic water threshold for water saving, there are some situations when it is impossible to stop the volume from dropping down to zero or close to zero (days 220-250).

6.1.3 Travellers influence

Last but not least, given that, unfortunately, travellers and visitors to Bamba usually spend much more water than a local as average, it is important to take this fact into account and study their real influence.

Similarly to previous analysis, four cases have been supposed[39]:

- **50 Litres per day:** This is the minimum essential amount of water per day to guarantee hygiene and basic needs to be sufficiently covered for survival (according to the Food and Agriculture Organization of the United Nations [21]). Even though, as an average, African people have only access to around 20 L per day (according to World Wide Fund [22]).
- **100 Litres per day:** It has been calculated that the average visitor to Bamba spends around 100 Litres a day, which is some less than the actual average of a Spanish citizen according INE [17].
- **200 Litres per day:** Reasonably high amount that is usually spent in countries where there is not any type of restriction or lack, but temperatures are very high i.e. Dubai.
- **400 Litres per day:** Exaggerated amount in order to visualize the actual impact of an enormous consumption rate by the visitors to Bamba.

Please, refer to Section 5.1.1 in order to properly know where and how to change this value. In Annex 2: Consumption function, this parameter is called "*E_trav*".

Results from using this values are shown in the following plot:

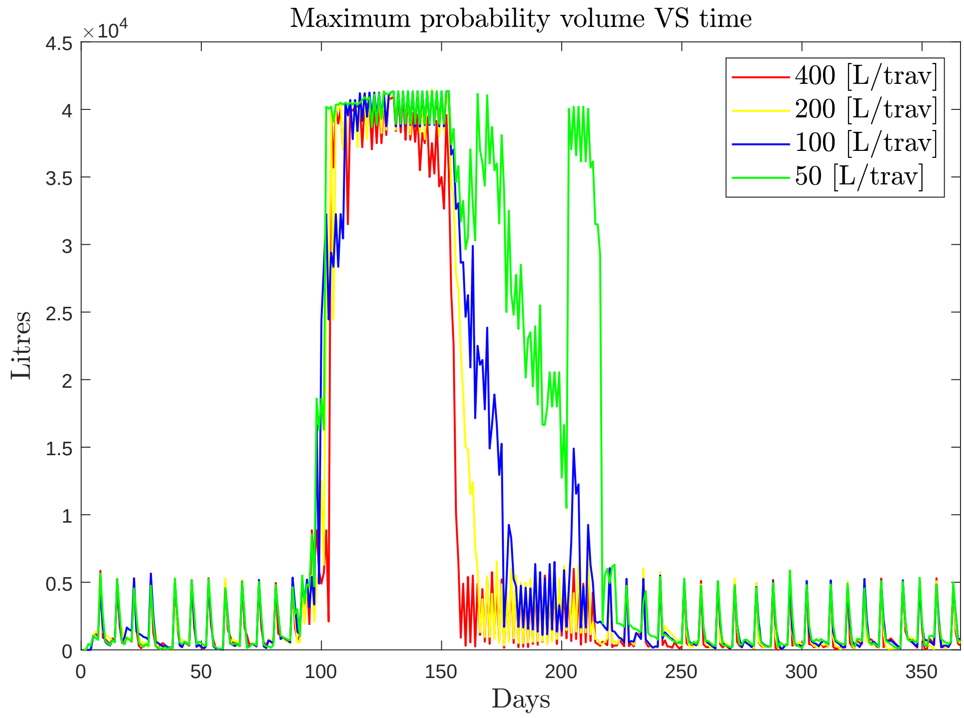


Figure 49: Travellers consumption influence comparison

In this last comparison, the frequency, amplitude, and mean value of the oscillations remains constant for all different cases. Nevertheless there is a really important impact on the amount of time the deposits are full and, as a consequence, the range in the year in which they do not have to apply any kind of restrictive consumption policy.

[39]Please, refer to Figure 20 to visualize following values

The amount spent per traveller per day influences most the slope of the line dropping from the tanks full volume down to zero after the rain season. This means that the less they spend, the longer will Bamba remain with water in the deposits while there is not any pluviometric income. It is really interesting to see how, with a reduction of only 50 Litres per day, the time until the deposits empty out increases up to two full months. The main reason for this is that the highest amount of visitors to Bamba is usually during European summer, which is when the rain season starts finishing.

As a conclusion, comparing with previous analysis, the amount spent by each visitor to Bamba has an astonishing influence, even more than the amount of water received by the government or their water saving consumption policy threshold. It is really important to take this into account when travelling abroad to countries which have water problems.

6.2 Consumption policy

In order to fully develop an efficient and optimum consumption policy, it would be necessary to develop a code that varies a considerably high amount of variables and compares the result as it was performed in previous section. An interesting approach would be to develop a Genetic Algorithm[39] (GA from now on) software with Matlab® that works in the following manner: In first place give the program a range of values for several different variables and solve the problem for all possible combinations. Bare in mind that the number of different possibilities scales exponentially with the amount of parameters that are being changed.

For previous case in which there were three scenarios with four values for every criterion, the number of combinations is $4^3 = 64$. For every one of them the computer should solve the main code with a reasonable amount of reliability, which means choosing: Number of years to compute the probability: 30-50. Given that each of them takes as an average 4:30 min, the total time would be 4.8 Hours. This is still an affordable time to run the program if the UC3M workstation can be used[40].

The Genetic Algorithm should vary at least 6 scenarios including: house consumption, shower consumption, laundry consumption, threshold for water saving, government input, travellers consumption, leaking consumption, number of kids and workers, possible alternative water saving expenses... Moreover, each of those parameters should have a wide enough range in order to properly see its influence, lets assume 5 values. Using the following equation:

$$N_{exec} = n_{val}^{n_{sce}} \tag{35}$$

$$T_h = N_{exec} * \frac{t_{exec}}{3600} \tag{36}$$

Where N_{exec} is the number of executions of the whole main code, n_{val} is the number of values each parameter sweeps, n_{sce} is the number of different scenarios and t_{exec} is the time to perform one full execution.

Therefore, giving a total of 15625 full executions and a total time of nearly 50 days.

In order for the GA to perform a deep learning each generation, we have to provide it with a condition[40]. In this case the condition could be: reduce both the number of days without water and the amount of days that water restriction has to be applied (values provided in Figure 45. This induces the GA to reject each generation those combinations with bad results and improve those which comply with the constraints. After a number of generations, the GA should have created a wide enough neuronal network that can give several different results:

1. <u>There is not</u> any optimal combination that complies with the given constraints, as increasing some parameters in the given range reduces the output of others.

2. <u>There is</u> an optimum, efficient combination of the swept parameters that gives a certain consumption along the year.

3. <u>There is</u> an optimum value for each parameter, but they are an impossible combination to implement in real life.

[40]Take into account that on a personal computer this might take up to two or three times depending on the computational speed and efficiency

In any case, it has to be the user the one who performs this analysis and supervises the GA in order to know if it is performing correctly[41] and complying within the given constraints.

Due to lack of time and resources, this analysis has not been made jet, but it will be performed in a close future and added to the project. Nevertheless, a combination has been picked according to the conclusions extracted from Section 6.1.

It was seen that the one of the best solutions was provided when the following parameters were chosen:

- **Water consumption per traveller:** 70 L
- **Threshold value for water saving:** 3000 L
- **Water received by the government:** 6000 L

Its corresponding **water consumption policy** should be the following:

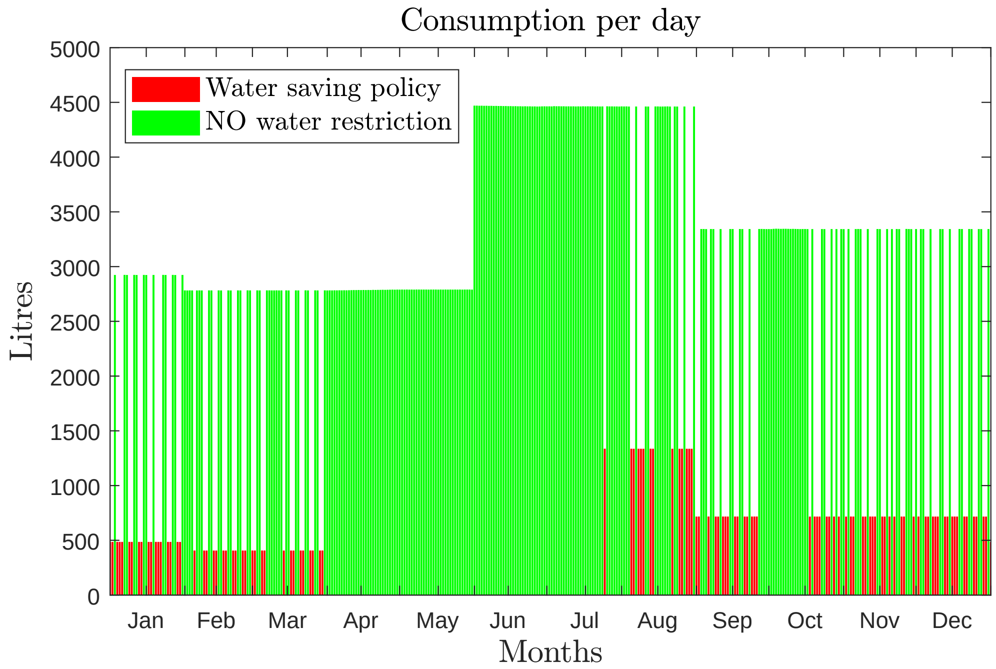


Figure 50: Maximum consumption in order not to be left out without water

6.3 Practical conclusions

The first conclusion obtained while searching for an optimum performance consumption and deterministic values for water consumed per traveller and water threshold was the following: it is incredibly tedious and time consuming executing the program each time a parameter is changed and, in many occasions, results do not comply with expectations. For example, when the amount of days with zero water wants to be reduced, it is a good procedure to increase the water threshold in order to start saving before the volume runs dangerously low. Nevertheless, increasing this threshold means increasing the amount of days per year that the water restriction policy is applied, which is indeed the other constraint to be reduced. Therefore it was thought that an approximate solution can be shown, but the optimum one can only be obtained using computational tools as Genetic Algorithms, Neuronal Networks, Artificial Intelligence...

Results for the selected parameters in previous section are:

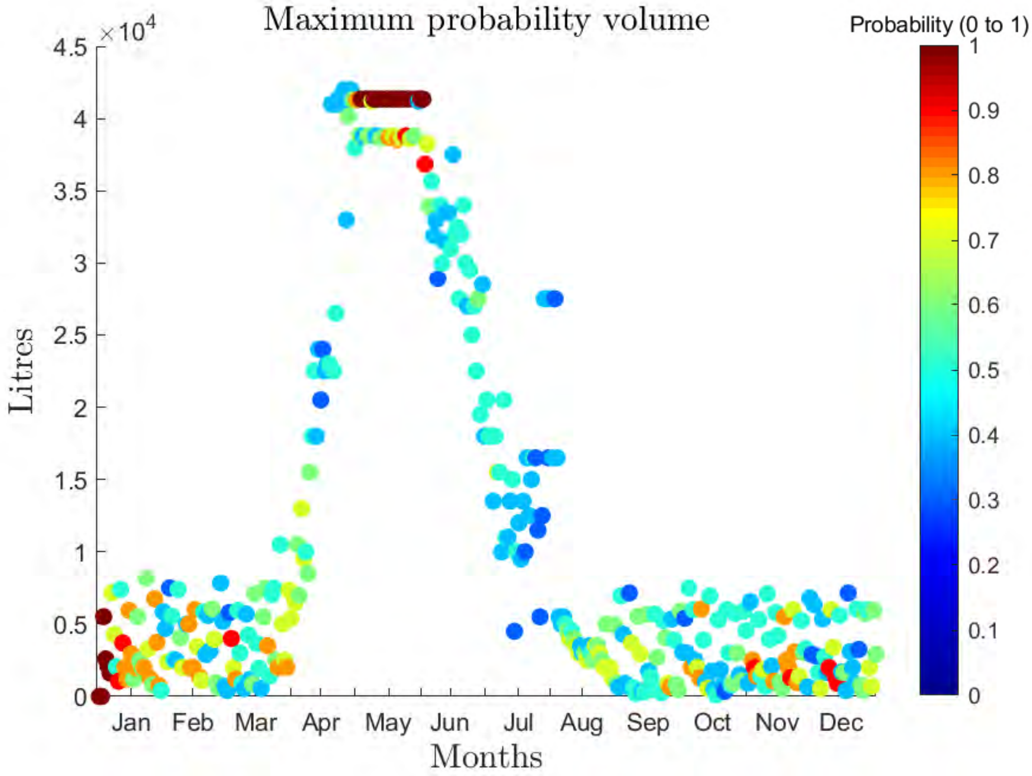


Figure 51: Maximum consumption in order not to be left out without water

Figure 51 shows that the method is sufficiently reliable as the probability of the vast majority of the points is over 40%.

It can be compared with Figure 43 and seen that the time between the rise of the volume to the drop after rain season is from 70 days to more than 90 (nearly a full month). Moreover, in this case, even though the amount of days that the consumption policy was activated is simmilar, there is only with day without water:

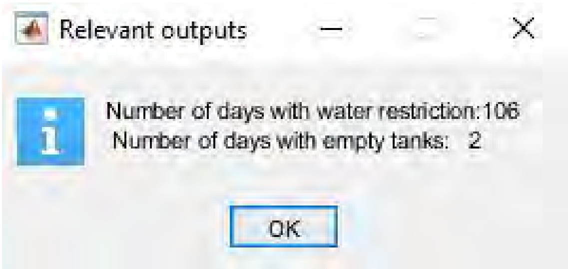


Figure 52: Relevant information regarding lack of water

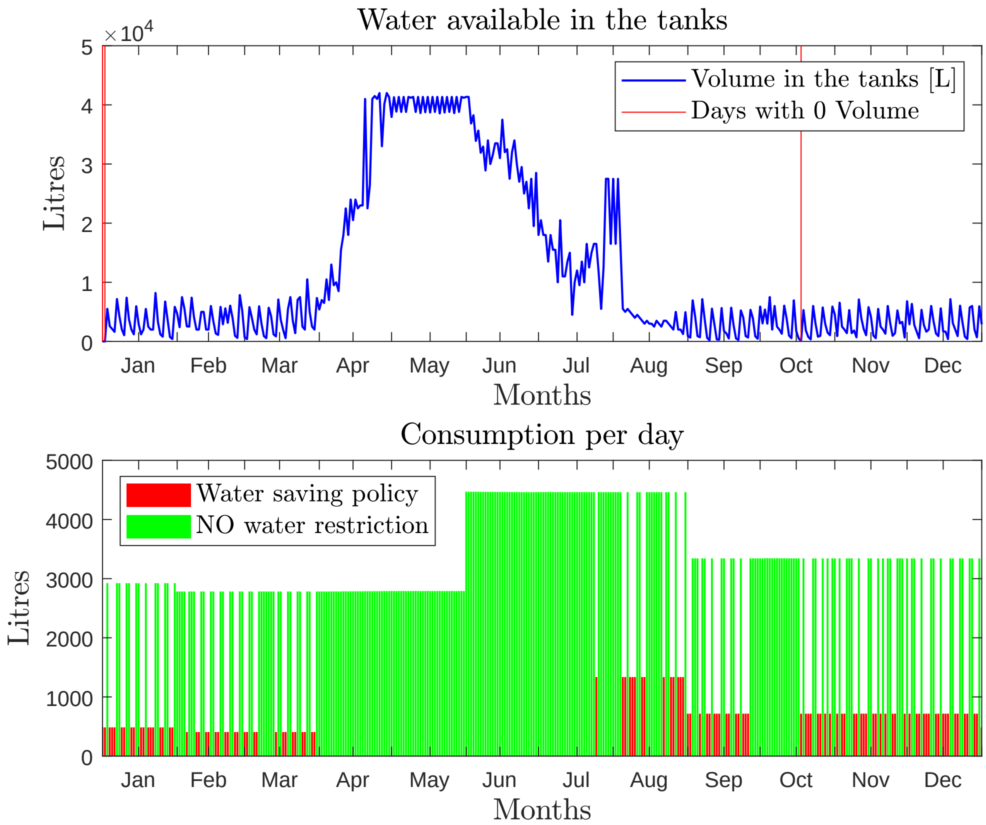


Figure 53: Maximum consumption in order not to be left out without water

Figure 53 shows that there is only a single day of the year (apart from the first day of the year, which is the initial condition) at which the volume drops to zero. This fulfills the main goal of the project of reducing the days when there is not sufficient resources even for drinking or cooking. Moreover, the number of days that they have to apply the restrictive consumption policy is relatively low even during the dry season.

Finally, the main conclusion from this analysis is that in order to properly manage the available water in their deposits it is necessary to have a tool that allows to predict future values in advance to reduce to a minimum the possibilities of running out of water.

Currently, in Bamba, several times in the year, they have to request for an extraordinarily expensive truck of water[41] in order to surpass critical dry moments of the year. With this tool, it has been proved that a proper administration of their resources provides sufficient water throughout all the year.

[41]See Interviews, where price and availability of water trucks is explained by local authorities and citizens

7 Construction of the main Deposit

The main problem in Bamba before thinking of any water management project, was its storage capacity. Up to July 2018, they did not have the main cement tank that has been mentioned several times in the project. Due to this, their maximum capacity was the resultant of the plastic tanks (refer to section 3.3.2 in order to visualize the position and capacity of each of them), which was 16.600 L.

In order to compare the difference between having this main deposit or not, the main tool software can be run with a maximum capacity of 16600 L[42].

The solution would be the following:

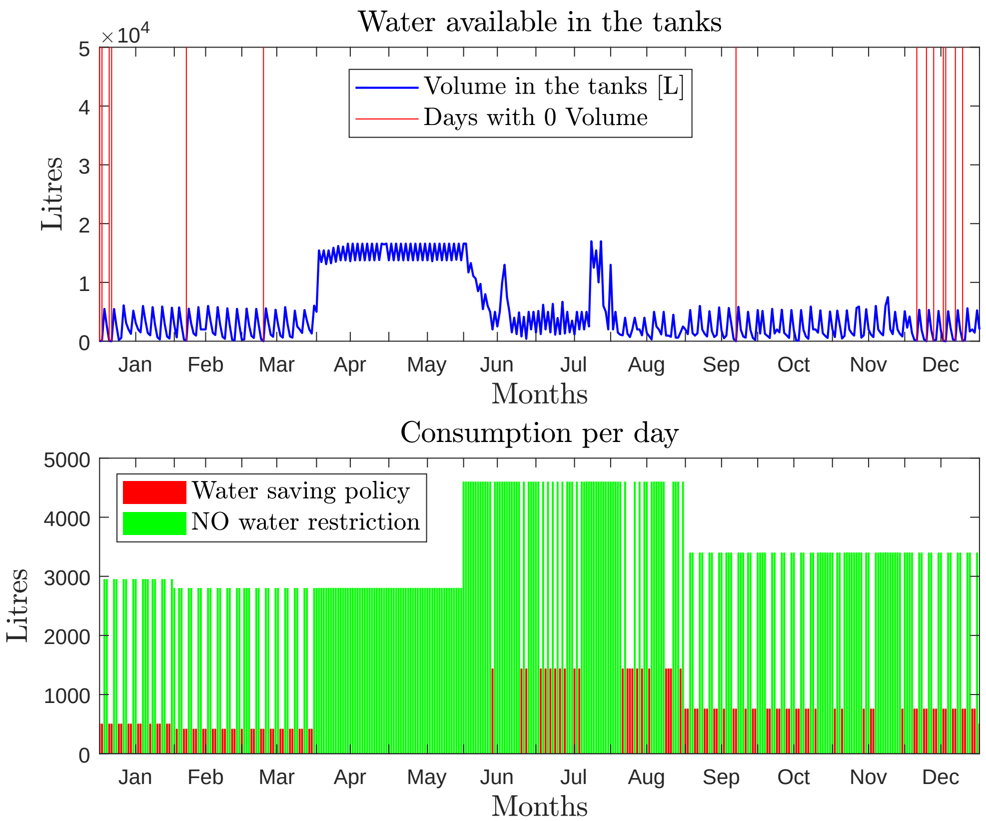


Figure 54: Consumption each day **without** the main tank compared to available volume

[42]This variable is called *"Max_Capacity"* and can be found in Annex 2: Random Year Function

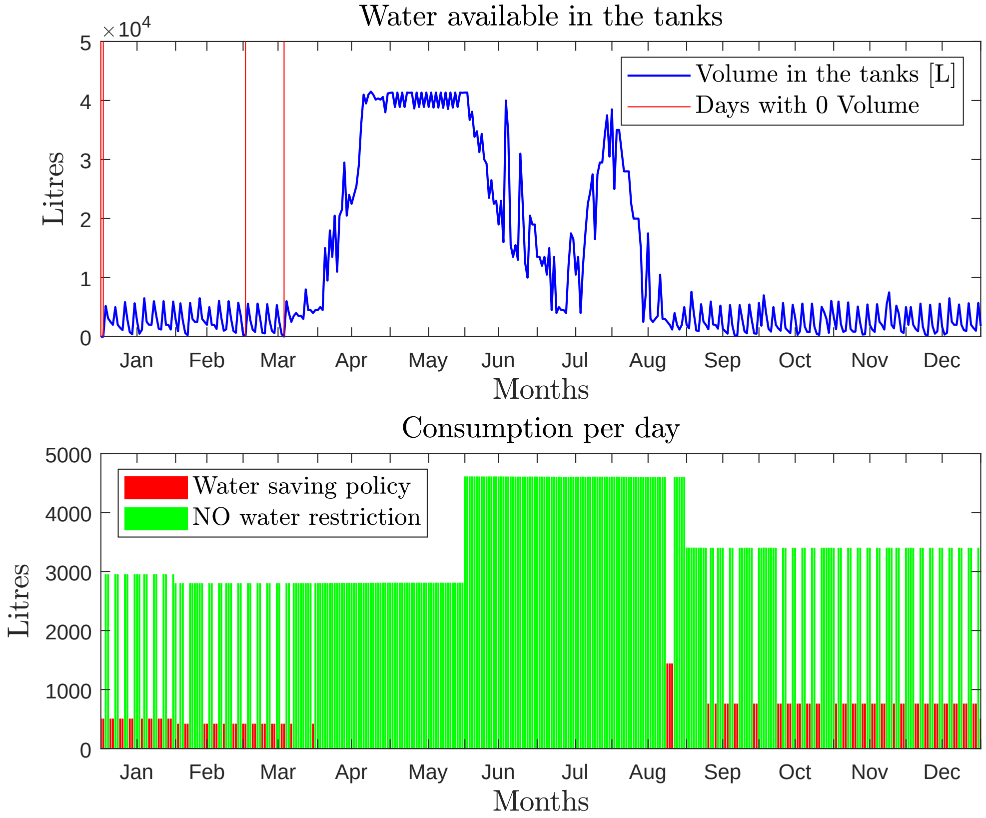
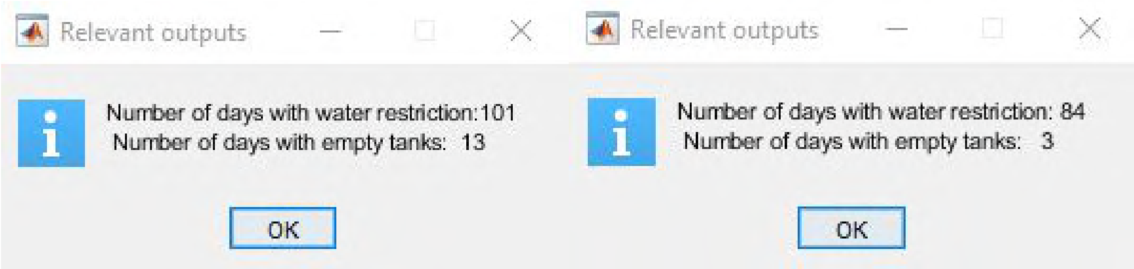


Figure 55: Consumption each day **without** the main tank compared to available volume

Figures 54 and 55 show the results of executing the program with the same values regarding travellers consumption, government water input, threshold volume value... but changing the maximum capacity (eliminating the cement tank).

As it can be seen in Figure 54, the cut on the Y axis is now much lower, which leads to a shorter super-habit term and a more restrictive consumption policy during the rain season. This means that the amount of days that they have to apply the water saving restriction is much higher[43]. In conclusion, by building this additional tank, they do not have to implement consumption restrictions up to August-September, compared with May-June which corresponds to not having this tank.

Moreover, as it can be seen in Figure 56, both the amount of days with consumption restriction and days without water were drastically reduced:



(a) No cement main tank (b) With cement main tank

Figure 56: Comparison between having or not the main cement deposit

[43]Remember that applying the water saving restriction means, as stated in Section 5.1.1, reducing by 75% most of the sources of consumption and eliminating laundry and shower (going to the river)

(a) Foundation

(b) Growth

(c) Total height

(d) coating

Figure 57: Different stages of the construction

During the first travel by the author to the orphanage (June 2017), it was already thought that building an additional storage tank was one of their primary needs, nevertheless, the problem was insufficient founding and low budget. This idea was proposed to the parents of Bamba (Rutto and Christine in Figure 1) and the NGO manager. Once the collaborators of Bamba Project were informed, some of them called Aduna Mitxelena, Itziar Ureña and Arantxa De Las Heras performed a crowd-funding thanks to her dance school *"Pauso K"*. They collected an astonishing amount of €2600. This was more than enough for the construction, which started during the next author's trip to Kenya on August 2018.

In the following images, the building process of the tank can be visualized:

Finally, and after covering it, the deposit can be visualized below:

Figure 58: Finished construction

Its dimensions are 5.5 m length, 2.5 m width and 1.8 m height.

As it can be seen, it was built with a wall in the middle which separates the main deposit into two individual compartments, each of them with an opening on top for cleaning.

7.1 Place and height

It might seem counter-intuitive, but it was built on the lowest part of the land owned by the NGO. The reason for this was the lack of space on higher parts. In Figure 59, its location can be visualized:

Figure 59: Location of the main deposit

Another reason for this positioning was to ease the delivery of rain water from the roofs during wet season.

7.2 Problems

The construction of this additional water container carried on several problems and drawbacks. The most important ones will be listed below:

- Due to the height at which it was built (30 metres below the rest of the tanks), carrying the water up every time it is needed on any of the other deposits implies an energy loss. This is because the only manner to deliver the water is using pumps, which need to be fed with electricity, which indeed, is not always available.
- Depending on the amount of time that water will remain motionless, purifying processes should be carried in order to ensure that it is suitable for consumption. Even though chlorination is not a difficult or expensive procedure, someone should be responsible of adding the correct amounts for PH not to be too high or too low.
- As most of the water going into this container will be coming from rain water from the roofs of the orphanage, some kind of filtration should be done in order to assure there is not insects, leaves or other objects going in.
- Unlike the rest of the deposits, this one is much wider and longer compared to its height. This leads to higher evaporation, taking into account that this region of Kenya has high temperatures and number of hours of sun per day.[44]

[44]This was decided during the author's travel to Bamba, as he had no other information or tool to calculate its necessary maximum capacity, it was decided to be built very long and wide so if it was necessary at some stage to increment its volume, an small height addition would provide with a much wider capacity.

- The distance between the main buildings of the orphanage and this tank is around 79 m, which makes any connection work very expensive and time consuming.
- As the length of the pipes for both the income and outcome from the deposit is very high, pressure losses will force a bigger pump to be bought. Besides, more leaking losses will have to be taken into account due to the high number of connections.

7.3 Arrangement

According the possible arrangements and connections between the main cement tank and the plastic ones, several options are available as a function of the budget and comfort[45]:

1. Connect all plastic tanks in height order and the main cement tank with the highest one. Therefore, in the case one of them needs to be filled, water would be carried from the bottom cement tank with a pump and late on, with gravity, water would go through all the intermediate inter-connected tanks until arriving to the objective. (Figure 60[46])

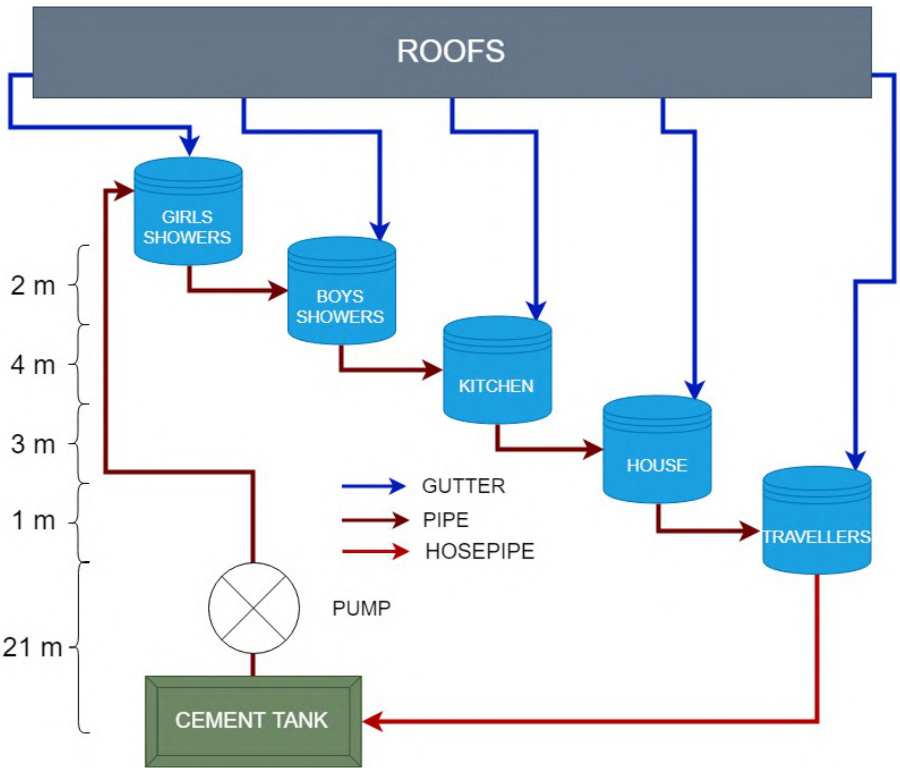


Figure 60: First arrangement option

This is one of the cheapest options as only two large pipes would need to be bought (one from the cement tank to the highest one and another from the lowest tank to the main deposit. Moreover, only one pump is needed, the rest of the work is done by gravity.

2. The next option is to connect the main tank with each of the deposits independently. This is more expensive as the main tank is very far away from all of them. Nevertheless it provides with the profit of having water as needed in any of the deposits without depending on the level of higher level ones. (Figure 61)

[45]Currently, there are not any connections between them. In the case of a necessary transfer from one to another, if the height of the receiving tank is lower, a simple pipe is used thanks to gravity. In the opposite case, a portable small pump is available

[46]The brackets at the left of the Figure show the altitude difference between each tank.

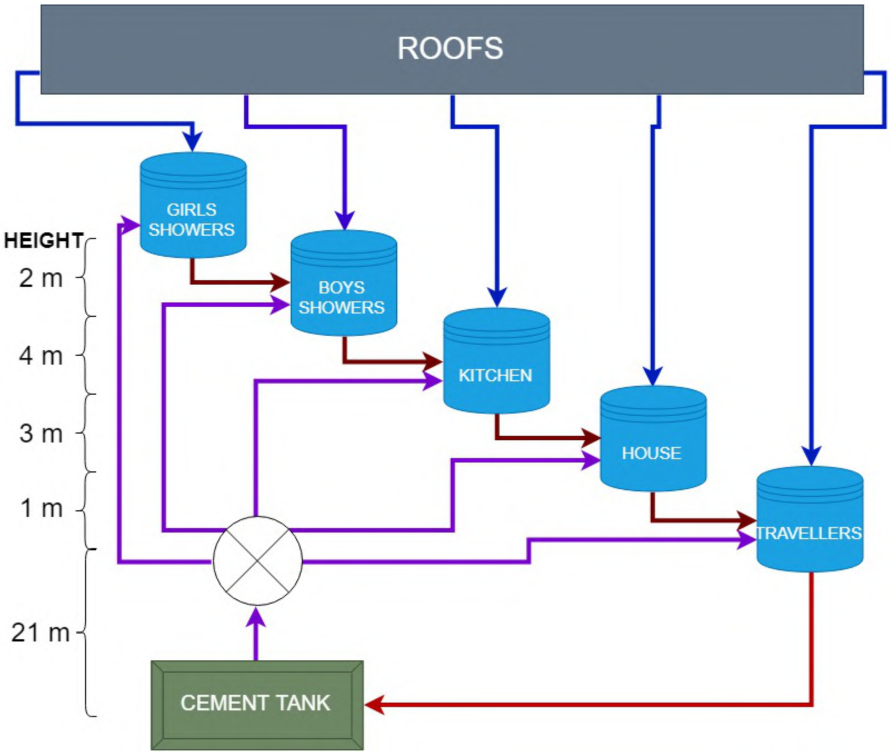


Figure 61: Second arrangement option

This one allows for having also only one pump. Although, when the main deposit is empty, we rely on the water availability of tanks at higher altitudes.

3. Finally the best but most expensive arrangement would be the following: Connecting the cement tank with every plastic one for both outcome and income. This provides independent control over each of them, which means that it does not matter which of them is full or empty because they will always have the option of delivering water down to the cement tank or receiving it. (Figure 62).

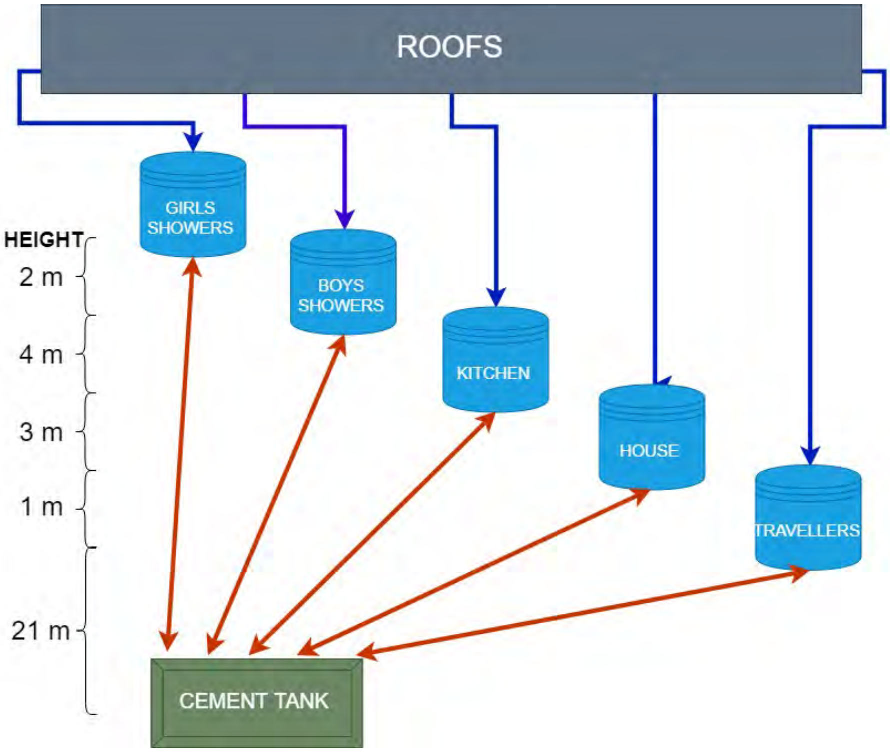


Figure 62: Third arrangement option

Depending on the budget available, this option would be very interesting as, a model could be created in order to manage the level of each of depending on the season in order for none of them to be empty. The main problem of this arrangement apart from economical reasons is the amount of pumps needed. As a result from the independence of each of the deposits, one pump for each hosepipe would be needed, increasing the energy consumption.

Concluding, depending on the budget, some of this three arrangements can be chosen, taking into account the benefits and drawbacks of each of them.

7.3.1 Pumps selection

Selecting a pump depends on the arrangement chosen in previous section. In the first option, the pump will only need to deliver water at an specific flow rate up to a height of 30 m above the cement tank.

In the second case, depending on the height, the pump can be more or less powerful, nevertheless it has to be sized to feed the highest one, therefore, the selected one for the first arrangement would be suitable.

Finally, if the third option is chosen, there are several options. The most interesting one is the following: create a model that, with small buoys in each of the deposits its level is measured in real time. An small Arduino® electronic board could be designed and coded. Its main purpose would be to activate an electro-valve in each of the hosepipes connected with the plastic tanks that delivers water whenever the level surpasses a minimum threshold value. This would suppose using one pump for every single tank, situated in the cement one.

In order to properly select the most appropriate pump, the following procedure has been followed:

The efficient power that can be delivered by a pump (not taking into account its efficiency) is[42]:

$$\dot{W}_{eff} \simeq \rho Q \left(gH + \frac{1}{2} \frac{Q^2}{\left(\frac{\pi D^2}{4}\right)^2} \frac{f L_{eq}}{D} \right) \tag{37}$$

Where:

- ρ is the density of the water $[Kg/m^3]$. In the current case equal to 1 Kg per Litre (Given that it is cold uncontaminated water[43]).
- Q is the flow rate $[Kg/s]$. In the current case, Bamba usually fills the deposits during the night, which means that a small flow rate is usually enough in order to fill an average of 4000 L. The range of values is from 300 to 3000 L/h.
- g is the gravitational force $[m/s^2]$. Taken as 9,80665.
- H is the height at which the pump delivers the water $[m]$. 30 metres is the maximum height from the cement tank to the higher level one, chosen in order conservatively size the power.
- D is the diameter of the pipe $[m]$. The hosepipe bought for carrying the water, according to the budget is 35mm diameter.
- f is the friction head losses coefficient $[KPa/100m]$ which, from the Moody Diagram in Figure 63 is 0.0128[47].

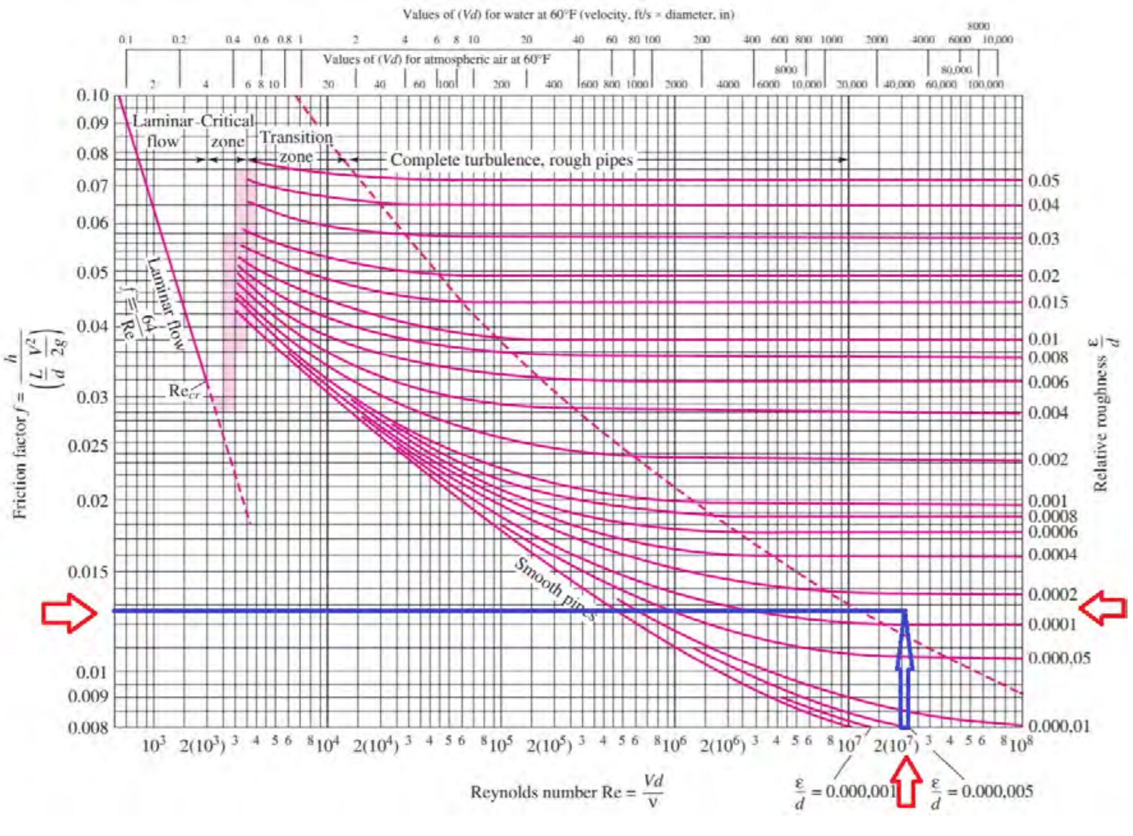


Figure 63: Moody Diagram

- L_{eq} is the equivalent length of the whole pipe. Taking into account all the corners, the full length has been estimated to be approximately 82 m. Although, this is the true length. In

[47] Relative roughness for this pipe is 0.00015 and Reynolds 10^7.[43]

order to calculate the equivalent one, it has to be multiplied by a factor that includes losses from bifurcations corners... This factor is 1.15 accordingly with UNE-EN-805:2000[44].

Introducing reference values in Eq. 37, it can be seen that the first term is bigger than the first one:

$$\frac{gH}{\frac{1}{2}\frac{Q^2}{\left(\frac{\pi D^2}{4}\right)^2}\frac{fL_{eq}}{D}} >> 1 \tag{38}$$

Therefore, this expression reduces to:

$$\dot{W}_{eff} \simeq \rho Q g H \tag{39}$$

The pump that has been already bought for Bamba is the *ESPA Aquaria 07 N*. In order to maximize its efficiency, its flow rate can be changed. According to its specifications[45] and observing its operating diagrams[48], its optimum efficiency is approximately 36%.

For a generic case and pump, the operating diagrams have a similar shape to Figure 64:

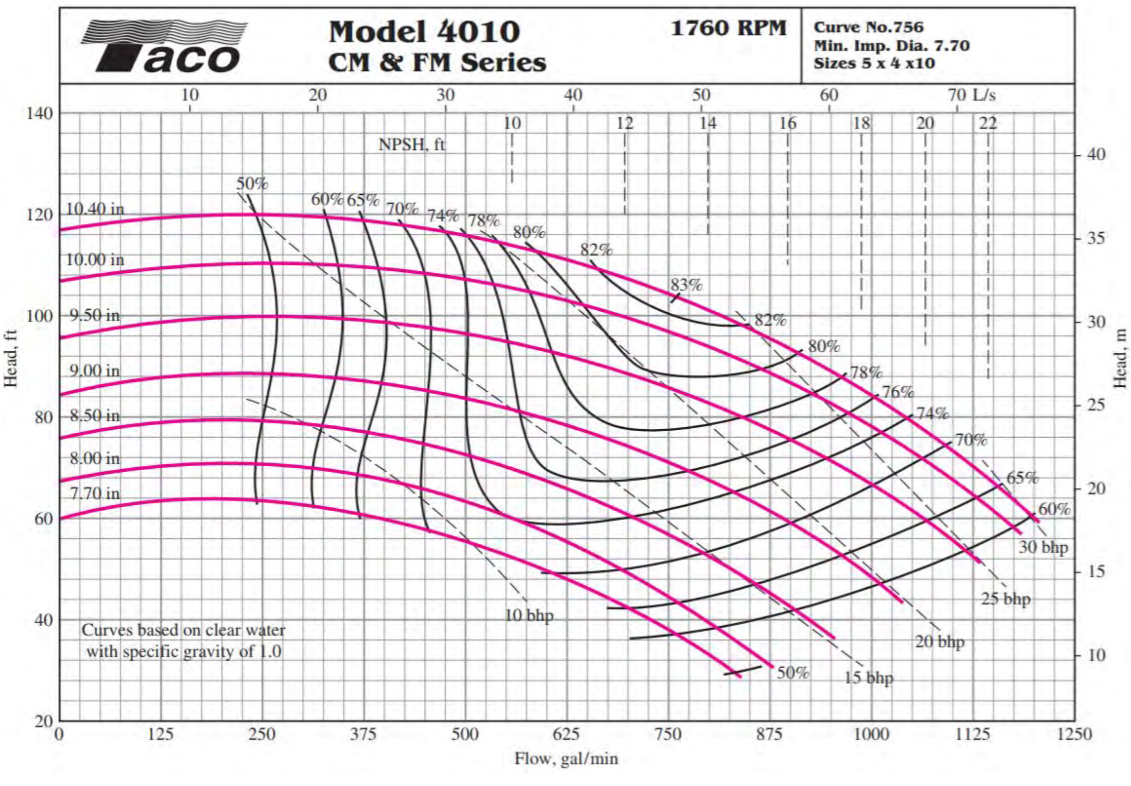
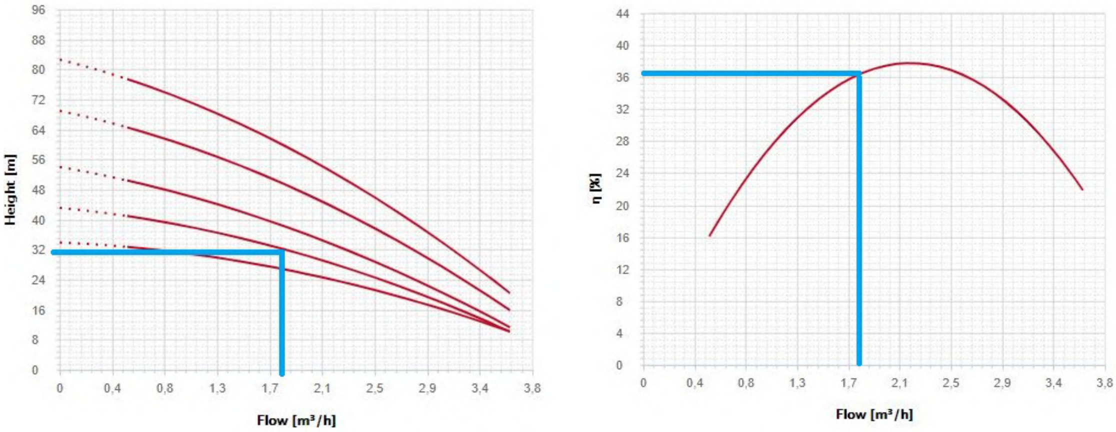


Figure 64: Performance data of a generic pump [42]

Taking this shape as an example, the actual pump for Bamba will be sized assuming 30 m pumping maximum height and varying flow rate in order to find the optimum efficiency.

[48] Please, find attached in Annex 4 all necessary pump specifications provided by the manufacturer.



(a) Height VS flow (b) Power VS flow

Figure 65: Operational diagrams for *ESPA Aquaria 07 N* pump

Figure 65a and 65b show the height and power VS flow respectively. The red line is provided by the manufacturer while the blue line is the selected operating point.

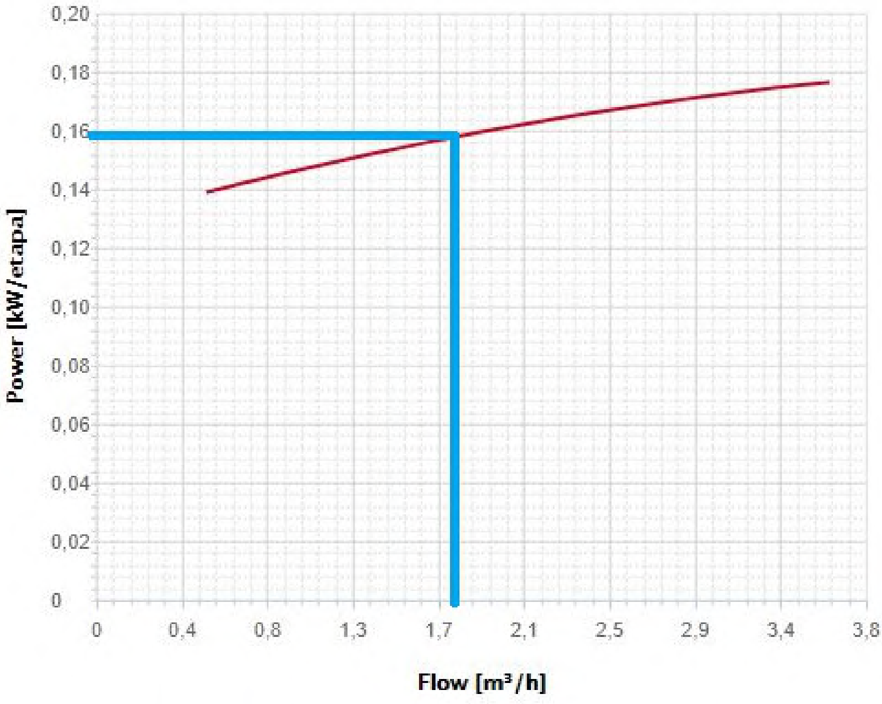


Figure 66: Efficiency VS flow

As seen in Figure 66 The efficiency corresponding to previously selected values is 36% (This is a very low efficiency value, nevertheless, it is common in this specific type of pumps).

W_{eff} can be obtained from Equation 39 and, including its efficiency:

$$\dot{W}_{real} = \frac{\dot{W}_{eff}}{\eta} \tag{40}$$

The real power required from the pump to deliver water at a 30 m height is 0.3859 [kW]. This value is relatively low, but it has to be taken into account that the flow rate is too. Although, they use to fill the tanks during the night, which means that a flow rate of 1700 L/h is more than enough to fill even the biggest plastic deposit of 5000 Litres volume capacity.

7.4 Maintenance

Independently from the arrangement, pump or model selected, a certain maintenance should be performed with regularity in order to ensure the correct functioning of all the parts of the system, including chlorination, gutters, leakage, electronics, pumps, cleaning of the deposits... In any case, most of this is already being carried out by them and any new tasks that would be needed should be properly explained in order for them to have a model that are able to change and fix.

Providing Bamba workers with all the information regarding the project is one of the most important tasks because, as the author will not be living there, local workers should properly understand how and why everything was performed in order to be able to change, upgrade, fix or re-construct any part by themselves.

7.5 Budget and Financing

It has to be clearly stated that all information regarding possible arrangements is optional and can be enhanced or changed depending on their needs, nevertheless, as self financing is most of the times the most restrictive reason, a crowd-funding will be done for the most expensive parts.

For the first arrangement on Figure 60 the budget[49] can be seen in Table 4:

	Details	**Price per Unit**	**Nº of Units**	**Price (KSH)**
PVC pipe	10 cm Diam	215 [KSH/m]	65 m	13975
	7,5 cm Diam	202 [KSH/m]	37 m	7474
	0,5 cm Diam	193 [KSH/m]	30 m	5790
Hosepipe	25 mm Diam	105 [KSH/m]	50 m	5250
Sand	resource	1000 [KSH/Ton]	400 kg	400
	transport	500 [KSH/trip]	1	500
Cement	25 kg bag	650 [KSH/bag]	4 bags	2600
Pipe elbow	10 cm Diam	110[KSH/unit]	12	1320
Water passage key	35 mm adapter	48 [KSH/unit]	2	96
Electric cable	25 m rolls	55 [KSH/m]	100 m	5500
Pump	750 W	6500 [KSH/unit]	1	6500
Labor	3 workers	1200 [KSH/day/worker]	4 days	14400
TOTAL (KSH)	114,76 KSH = 1 Euro		KSH	63805
TOTAL (Euro)	0,0087 Euro = 1 KSH		Euro	555,104

Table 4: First arrangement budget

For the second one on Figure 61, Table 5:

[49] The prices per unit are subjected to currency fluctuations. The information regarding prices has been obtained from workers of the orphanage in the local hardware stores.

	Details	Price per Unit	Nº of Units	Price KSH
Hosepipe	25 mm Diam	105 [KSH/m]	320 m	33600
PVC pipe	10 cm Diam	215 [KSH/m]	65 m	13975
	7,5 cm Diam	202 [KSH/m]	37 m	7474
	0,5 cm Diam	193 [KSH/m]	30 m	5790
Sand	resource	1000 [KSH/Ton]	600 kg	600
	transport	500 [KSH/trip]	1	500
Cement	25 kg bag	650 [KSH/bag]	200 kg	5200
Pipe elbow	10 cm Diam	110[KSH/unit]	48	5280
Water passage key	35 mm adapter	48 [KSH/unit]	10	480
Electric cable	25 m rolls	55 [KSH/m]	180 m	5500
Pump	750 W	6500 [KSH/unit]	1	6500
Labor	3 workers	1200 [KSH/day/worker]	6 days	21600
TOTAL (KSH)	114,76 KSH = 1 Euro		KSH	72899
TOTAL (Euro)	0,0087 Euro = 1 KSH		Euro	634,221

Table 5: Second arrangement budget

Note that in this case, as the cement tank is connected to each of the plastic tanks, at least 70 meters of hosepipe per connection are needed. Moreover, in order to cover the pipes, a higher amount or cement will be used and more workhand. In this case ten water passage keys are used as at least one for each pipe is necessary at the start and end of it. Regarding electric cable, as the same pump is being used from previous case, there is no change.

Finally, if the arrangement selected is the last one on Figure 62, its corresponding budget would be corresponding to Table 6:

	Details	Price per Unit	Nº of Units	Price
PVC pipe	10 cm Diam	215 [KSH/m]	160 m	38700
	7,5 cm Diam	202 [KSH/m]	75 m	19190
	0,5 cm Diam	193 [KSH/m]	90 m	23160
Hosepipe	35 mm Diam	105 [KSH/m]	325 m	34125
Sand	resource	1000 [KSH/Ton]	600 kg	600
	transport	500 [KSH/trip]	1	500
Cement	25 kg bag	650 [KSH/bag]	200 kg	5200
Pipe elbow	10 cm Diam	110 [KSH/unit]	48	5280
Water passage key	35 mm adapter	48 [KSH/unit]	10	480
Electric cable	25 m rolls	55 [KSH/m]	180 m	5500
Pump	Fuel Pump	28000 [KSH/unit]	1	28000
Labor	3 workers	1200 [KSH/day/worker]	11 days	39600
Arduino Board	includes elec comp	2300 [KSH/unit]	1	2300
Foam ball	5 cm D sphere	150 [KSH/unit]	5	750
Metal bar	Aluminum	230 [KSH/m]	12 m	2760
Electro-valve	9 V	2490 [KSH/unit]	5	12450
TOTAL	114,76 KSH = 1 Euro		KSH	200335
TOTAL (Euro)	0,0087 Euro = 1 KSH		Euro	1742,91

Table 6: Third arrangement budget

As it can be seen, this one is longer, as electronic components take place in order to measure the level of the deposits and activate the electro valves to fill independently each deposit. This orders are sent by the Arduino® board which would have been previously coded.

The cost of construction of the cement deposit itself can be broken down as in the Table 7:

	Details	Price per Unit	Nº of Units	Price (KSH)
Sand	resource	1000 [KSH/Ton]	10000 kg	10000
	transport	500 [KSH/trip]	1	500
Cement	25 kg bag	650 [KSH/bag]	50 bags	32500
Iron reinforcement	bars	4500 [KSH/bar]	20 bars	90000
Water proof material	20 kg bag	400 [KSH/bag]	10	4000
Labor	3 workers	1200 [KSH/day/worker]	21 days	75600
Plastic lone	roll	4000 [KSH/roll]	2 rolls	8000
Bricks	lorry 10000 Units	8 [KSH/brick]	10000	80000
TOTAL	114,76 KSH = 1 Euro		KSH	300600
TOTAL (Euro)	0,0087 Euro = 1 KSH		Euro	2615,22

Table 7: Cement deposit budget

8 Waste water management

Unfortunately, currently in Kenya, only the big cities have a sewer system. Due to this, each house has its own system. Most commonly, latrines are used for human excretions. Moreover, for cleaning waters, they undergo no treatment and are thrown to the ground.

Nevertheless, for the case of hospitals or big homes as Bamba, they usually have their own sewer system. As it can be read in the interviews made to local cohabitants, hospitals use lagoons and big houses or factories use septic tanks.

In the case of Bamba, their septic tank is the following:

Figure 67: Septic tank of Bamba

Cleaning waters with chemicals, shower, flushing... are the main waste water in Bamba. They all go to two different tanks. Figure 67 shows the first of them. The second one is a previous project of a traveller to Bamba. It corresponds to a three stage water filtration deposit. When it was built, it could clean water and make it usable for irrigation. Although, currently, due to the lack of maintenance and cleaning, it is no more capable of filtering. Therefore, it works as another septic tank.

This project would like to include the treatment of all the waters after its use in order to close its cycle. It is believed to be just as important as water income management, to be able to deliver it back to the environment with the minimum impact to the Earth.

To this end, it is necessary to differentiate between the two main types of waste water:

1. **Sewage water:** It corresponds to water contaminated by human excretions.
2. **Cleaning waters:** They correspond to water contaminated by chemicals.

8.1 Treatment and recycling of sewage waters

In order to correctly treat human waste related waters, it is really important to take into account that it has a high risk of spreading diseases as cholera if not correctly treated. Once this has been taken into account, a new alternative to current system of Bamba is going to be presented:

There is a fairly new concept called *Dynamic Lagoons or Aerated Facultative Lagoons*[46]. It corresponds to a closed circuit composed by different plants which receive the dark water at the start and allows the flow of water throughout the circuit. The main characteristics of this plants is that they perform an-aerobic degradation of organic water, which means that they are able to disseminate and disintegrate all human excretions and transform them into land fertilizer. The time that it takes for the water to finish the circuit is around a week and, after it has arrived to the end, this water is completely usable for irrigation purposes with no risk of environment contamination.

The following Figure shows the different species that can be used for this kind of water filtration:

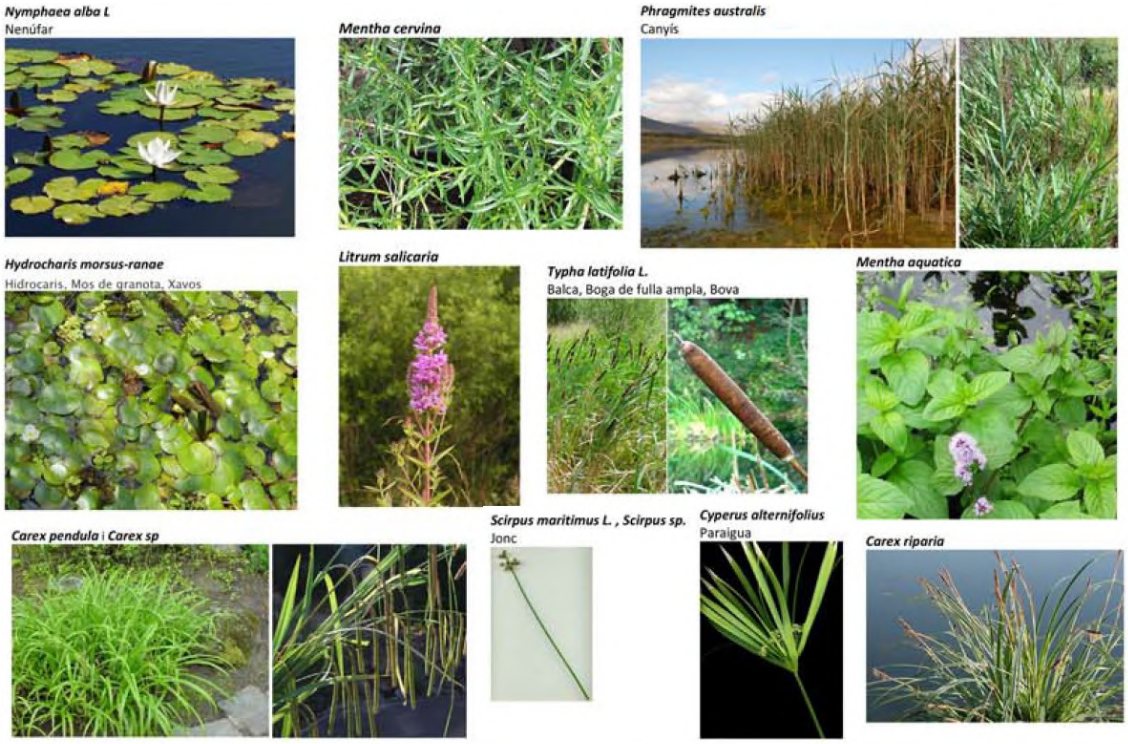


Figure 68: Dynamic lagoons species

The water cycle followed by the water should be similar to this[50]:

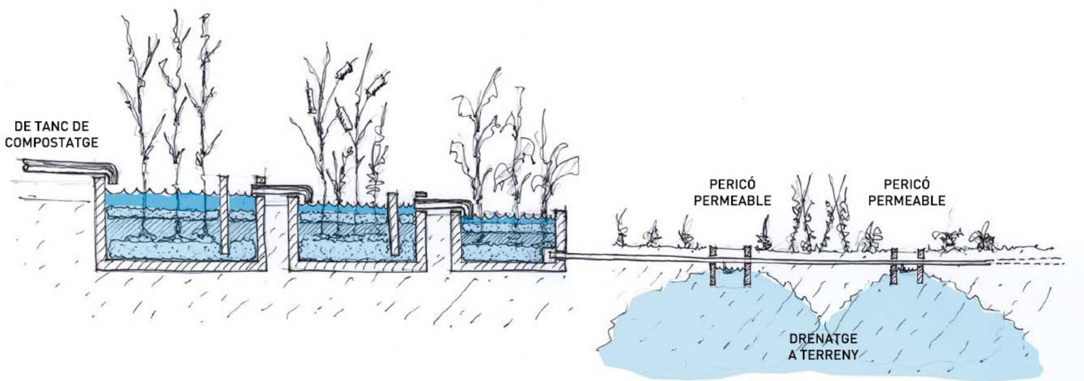


Figure 69: Dynamic lagoons sketch

Regarding water recycling, there is another system which could be implemented in Bamba[47]. It consists on storing for a short amount of time (2-3 days) the water from the shower uses in order to flush the toilets. It might appear that it has no impact but, in order to calculate its real impact, the mathematical tool from Section 5 has been used. In this case, the house consumption has been lowered from 200 litres plus 20 per traveller to zero plus 20 per traveller. This is because travellers use as an average 20 litres per day from the main house, and correspond to kitchen or cleaning purposes but no shower or flushing. Nevertheless, in the 200 litres taken into account,

[50]The figure is in Catalan because the person who developed this project was from Barcelona, nevertheless, the point of Figure 69 is to help the reader make an idea of what the Aerated Facultative Lagoons work.

flushing from all the workers and kids is taken into account. In this case they would be using only shower water.

Moreover, the water expense per traveller has been lowered by 20 litres per day as it is expected that their shower water is used everyday for flushing the toilet also.

The results from this analysis are shown below:

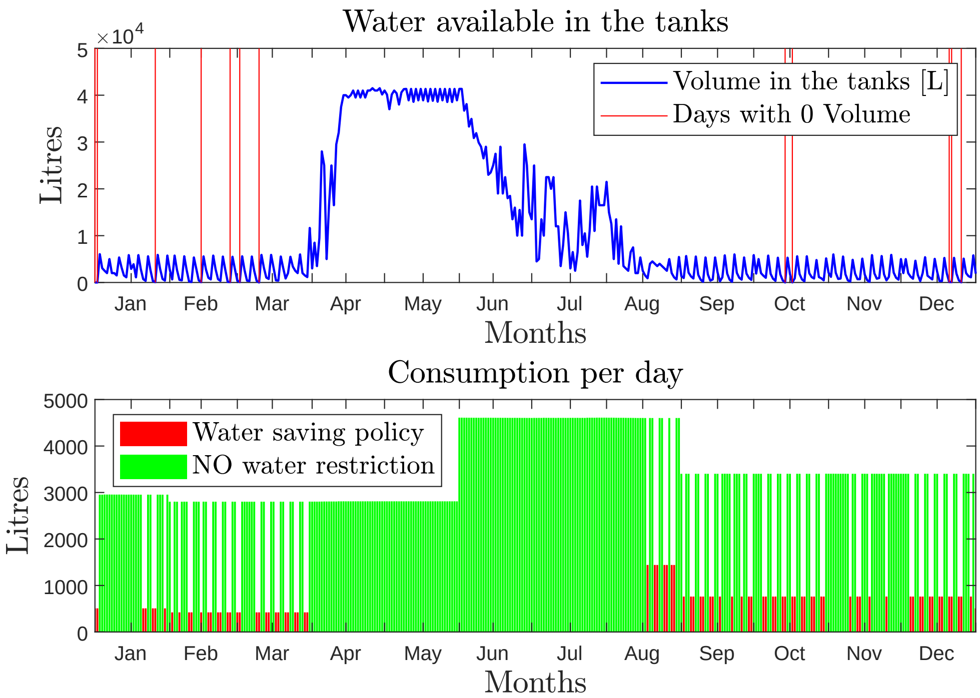


Figure 70: No water recycling from shower

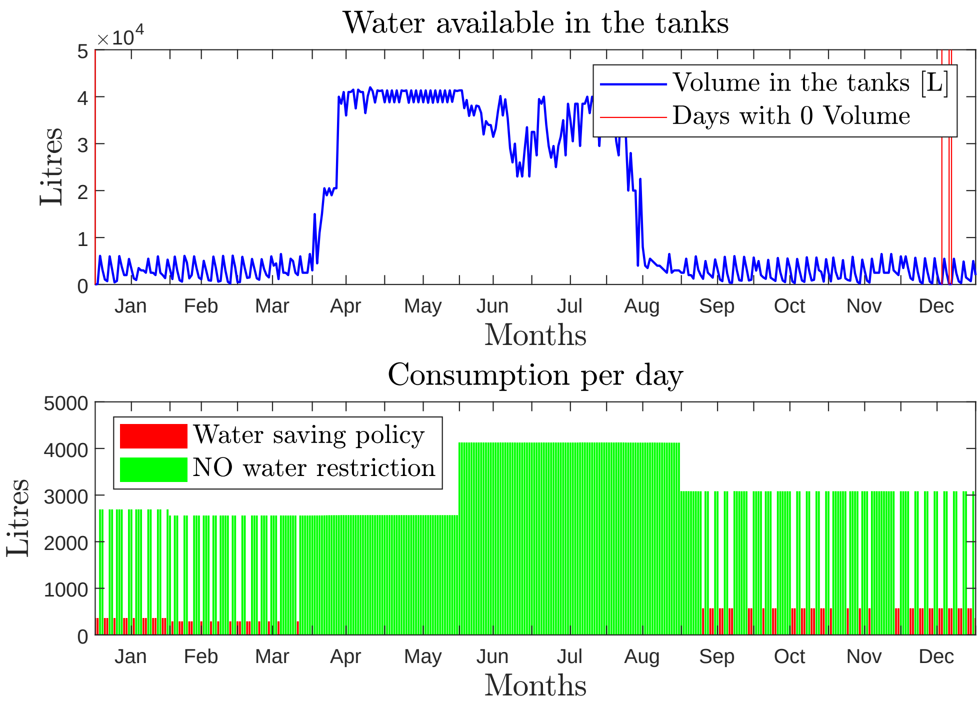
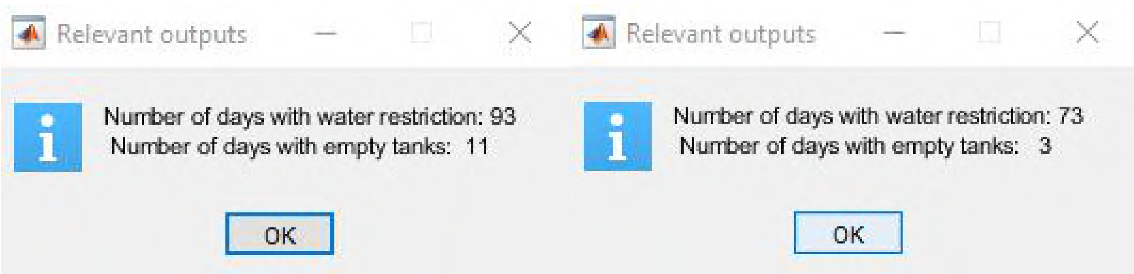


Figure 71: Water recycling from shower

There is a clear difference on the months of June to August in Figure 70 compared with Figure 71. The slope of the lowering volume line is much less pronounced in the second case, which increments the amount of time they have super-habit of water and therefore, reduces the number of days they have to apply a consumption policy. Indeed, Figures 72a and 72b, show this difference with numerical proof:



(a) No water saving (b) Water saving

Figure 72: Comparison between re-using or not shower water

Given this results, it becomes of a great importance taking into account a possible water re-using systems which are usually really cheap.

8.2 Treatment and recycling of cleaning waters

Cleaning waters include laundry, floor and house washing, dish washing and showers. The main link between them is the use of chemicals. The problem regarding this waters is that dynamic lagoons plants are not able to filtrate them, in fact, this chemicals would kill them. This is why the three stage filtration deposit was built several years ago[51]. The proposal in this case is to perform

[51] In Annex 3: Bamba building Diagrams[48], the complete project can be seen

a deep cleaning in order to be able to use it again. Furthermore, a maintenance duty should be assigned to some worker in order to check acidity and contamination levels of the water leaving the deposit every week and add sulfuric acid and/or chlorine as needed.

Following Figure shows the sketch of the actual three stage filtration deposit in Bamba:

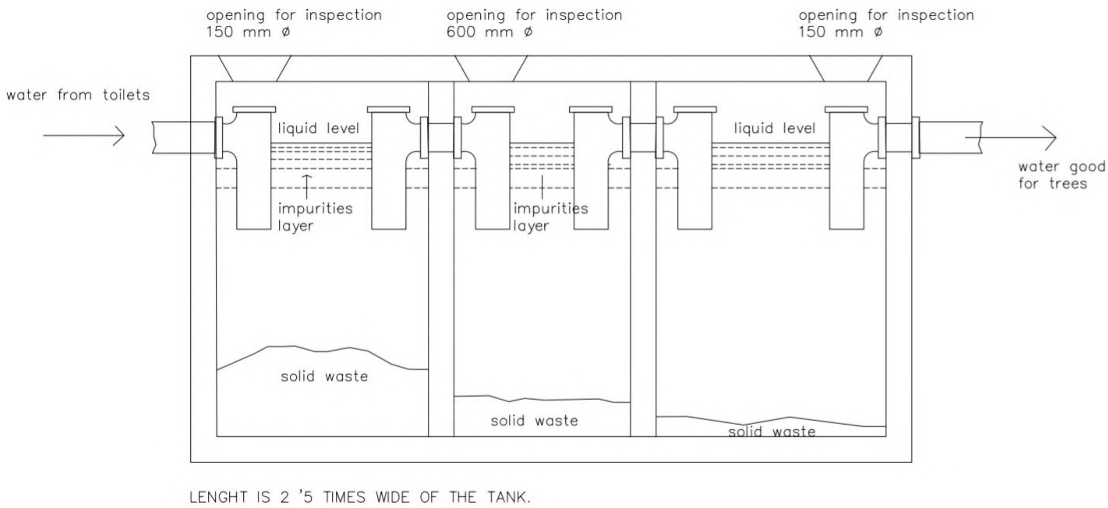


Figure 73: Three stage filtration deposit

The current solid waste has gone up to the impurities layer, which leads to dirty water flow from one stage to another without filtration.

As it could have been appreciated, there is a compatibility problem between the flushing water saving proposal defined in previous paragraph and this one. This is because for the shower, chemicals are used, which would send to the dynamic lagoons this waters.

In order to avoid this incompatibility there are two main alternatives: the first one would be to use non-aggressive soaps and the second one would be to make use of the water filtration deposit only.

8.3 Results and conclusions

This section's purpose was to close the water cycle and ensure no harm or damage is done to the environment after the water has been used. Two different plans have been stated.

The first one relies on re-using water from showers for flushing the toilets and, as it could be appreciated in Figures 71 and 70, the impact on the overall year volume of water is really high.

The second one refers to the water treatment depending on the use: for the case of sewage organic water, dynamic lagoons could be used and for the case of chemical contaminated waters, the three stage water treatment plant should be used taking into account its maintenance.

This proposals taken into account all together would provide Bamba with a sustainable water management environmentally friendly.

9 Energy problem

Bamba home benefits from the local electricity supply, which means that has access to electricity resources throughout the whole year. Nevertheless, there are two main problems in this field:

1. The price is particularly high with respect to the level of life. As it can be seen in Figure 86, which corresponds to the electricity bill, the monthly amount fluctuates depending on the season from approximately 2500 to 5000 KSH, which is 21 to 43 €. This would even be expensive for a normal home economy in Spain. Take into account that the average salary in Kenya according to World Data[49] is 122$ = 107.85 € compared to 2263$ = 200.59 € in Spain.

2. There is numerous electricity shutdowns, specially during strong rains and thunderstorms. In principle this should be no problem if electricity came back in a short period of time. Although, this is usually not the case. According with the Interviews performed to local people, shutdowns go from few hours up to two or three days. In the worst case, if a long cut of electricity coincides with several deposits emptying out, there would be no pump to deliver the water from the main cement tank to the higher level deposits.

9.1 Available energy resources

Given previous facts, it became of a notorious importance thinking about using a different energy source. Following the idea of having the minimum possible impact to the environment as in previous section, renewal energy sources were proposed to the NGO manager. Mainly wind and solar were studied to be implemented.

Soon, it was realized that, given the amount of hours of sun per month and year of Kenya and particularly, Kabarnet, the most efficient method would be to install solar panels. According to Dagoretti station[50] (Kenya weather station close to the orphanage), this region has 3114.2 hours of sun per year. This is much more than European countries as France (1662 [h/year]) or even Spain (2591 [h/year]).

9.1.1 Exploited energy resources

Up to this year, in Bamba , they did not have any other source of electricity but the one provided by the village. Fortunately, thanks to a very big crowd-funding contribution, Rocío (NGO manager) decided to buy several solar panels in order to supply with energy most of the sources of consumption of the orphanage.

Figure 74 shows the installation of this panels on the 16^{th} of March 2019.

Figure 74: Solar panels installation

The green panels on the back correspond to water heating solar panels while the ones on the front are photo-voltaic plates.

Thanks to this installation, they have reduced significantly their electricity bill, not only for having the ability to produce electricity but also because one of the main sources of consumption was the showers, which use resistances for heating the water and need high power. With the water heating panels they can obtain hot water with no electricity expense.

9.2 Budget

Even though it might seem reasonable that the six photo-voltaic plates are more expensive than the water heating ones, as it can be seen in Figure 75, the total amount spent was 365900 KSH, which corresponds to 3193.49€[52]

[52] Take into account that the currency is constantly fluctuating. For this case, the value used was $1KSH = 0.0087e$

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Quote No.	DM/31/03/2017/001
Customer ID:	
Quotation Valid	30 days
Page	1 of 1

Bill To:

Description
Project Type : Supply & installation .
Requirements : PV System
Site Condition : Lighting system.

Item	Description	Qty	Unit Cost (KSH)	Line Total (KSH)
1	Solar PV modules 200W	5	14,000.00	70,000.00
2	Solar RADOX cable 6sq.mm sc	20	150.00	3,000.00
3	100w LED bulb	4	32,000.00	128,000.00
4	charge controller 60amps	1	19,500.00	19,500.00
6	Battery Fuse 250A with the carrier	1	6,400.00	6,400.00
6	1kw must inverter	1	30,000.00	30,000.00
7	Battery stand	1	15,000.00	15,000.00
7	AC Control panel 4way 100A breakers	1	5,500.00	5,500.00
8	AC cabling of the pv system	lot	15,000.00	15,000.00
9	Solar mounting structure	lot	25,000.00	25,000.00
10	Battery cable	4	1,500.00	6,000.00
9	Accessories & Fittings	lot	13,000.00	13,000.00
10	Isolator	1	4,500.00	4,500.00
12	Installation and commissioning cost for the system	lot	25,000.00	25,000.00

Special Notes and Instructions

Payment Terms: Cash/Cheque		
80% On order and confirmation	Ksh.	292,720.00
20% on delivery/collection and commissioning	Ksh.	73,180.00

Sub-Total	365,900.00
VAT Rate	16%
VAT	Inclusive where applicable
Total (KSH)	365,900.00

Make all cheques payable to Solar Works E.A Ltd

Thank you for your business!
prepared by stephen
M.0713317581

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Tel: 0712070760 Fax: 0 E-mail: info@solarworksealtd.co.ke Web: www.solarworksealtd.co.ke

Figure 75: Solar panels installation Budget

Finally, Figure 76 shows the amount spent on the water heating system was 472000KSH, which corresponds to 4119.51€. Bamba project publishes their projects on their web page http://www.bambaproject.org/ and many collaborators contribute economically in the crowd funding until the necessary amount is reached.

For the current project case, a similar pattern will be followed.

SOLARWORKS
YOUR SMART SOLAR COMPANY

SOLAR WORKS E.A. LTD
SAKU BUSINESS PARK, UNIT 2
NORTH AIRPORT ROAD
P.O. BOX 28546-00100
NAIROBI, KENYA

Date:	March 8, 2019
Quote No.	S/001/2019
Customer ID:	
Quotation Valid	30 days
Page	1 of 1

Bill To:

Description
Project Type : Supply and installation
Requirements :
Site Condition :

Item	Description	Qty	Unit Cost (KSH)	Line Total (KSH)
1	150 ltrs water heating system	4	95,000.00	380,000.00
2	Accessories	lot	40,000.00	40,000.00
3	Installation cost	lot	52,000.00	52,000.00

Special Notes and Instructions
Payment Terms: Cash/Cheque

80% on order and confirmation	**Ksh.**	**377,600.00**
20% on delivery,installation and commissi	**Ksh.**	**94,400.00**

Sub-Total	472,000.00
VAT Rate	16%
VAT	Inclusive where applicable
Total (KSH)	**472,000.00**

Make all cheques payable to Solar Works E.A Ltd

Thank you for your business!

prepared by stephen
M. 0713 317 581
Saku Business Park, Unit 2 North Airport Road, Nairobi, Kenya, 0, 28546-00100
Tel: 0712070760 Fax: 0 E-mail: info@solarworksealtd.co.ke Web: www.solarworksealtd.co.ke

Figure 76: Solar panels installation Budget

10 Bamba Home Final Project

In this project numerous problems have been tackled. It becomes therefore undoubtedly important to summarize the developed solution for each of them in order to analyze how the objectives have been reached.

10.1 Water management proposal

Matlab® software has been used in order to generate a tool which provides with the expected volume of water that will be available in the tanks each day of the year. Moreover, a consumption policy is generated following the constriction of not being left without water. This tool uses as an input a complete set of data for the rain flow each day of the year. It is therefore possible to apply it in any other part of the world in which this data is available (in format .xlsx or as a data cell in Matlab®). Nevertheless, in this case, the tool is adapted for the conditions given in Bamba home as: maximum capacity, consumption per person per day, roof area, loss coefficients... Due to this, this variables should be changed in order to make use of the program in other environments.

After several executions and as a conclusion, the volume each day and the recommended corresponding consumption is the following:

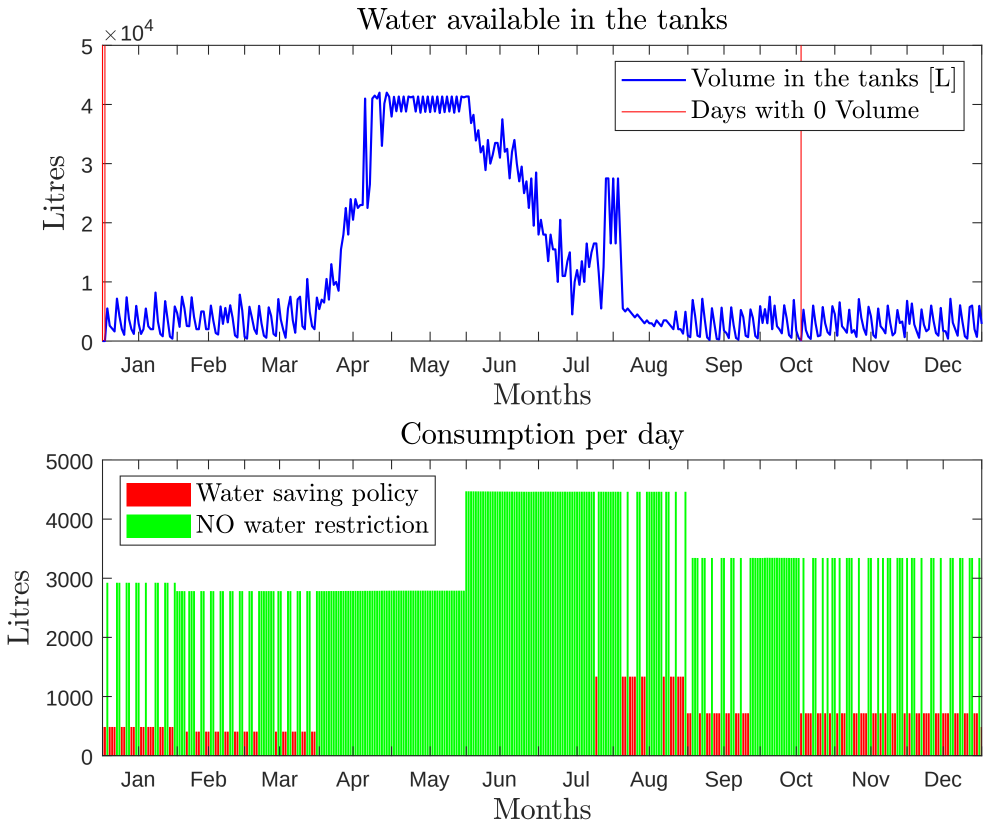

Figure 77: Maximum consumption in order not to be left out without water

It was also studied that, with a very simple system that re-uses some water from the shower for flushing the toilets, the consumption policy could be further reduced (made less strict), as seen in Figure 78 compared with Figure 77:

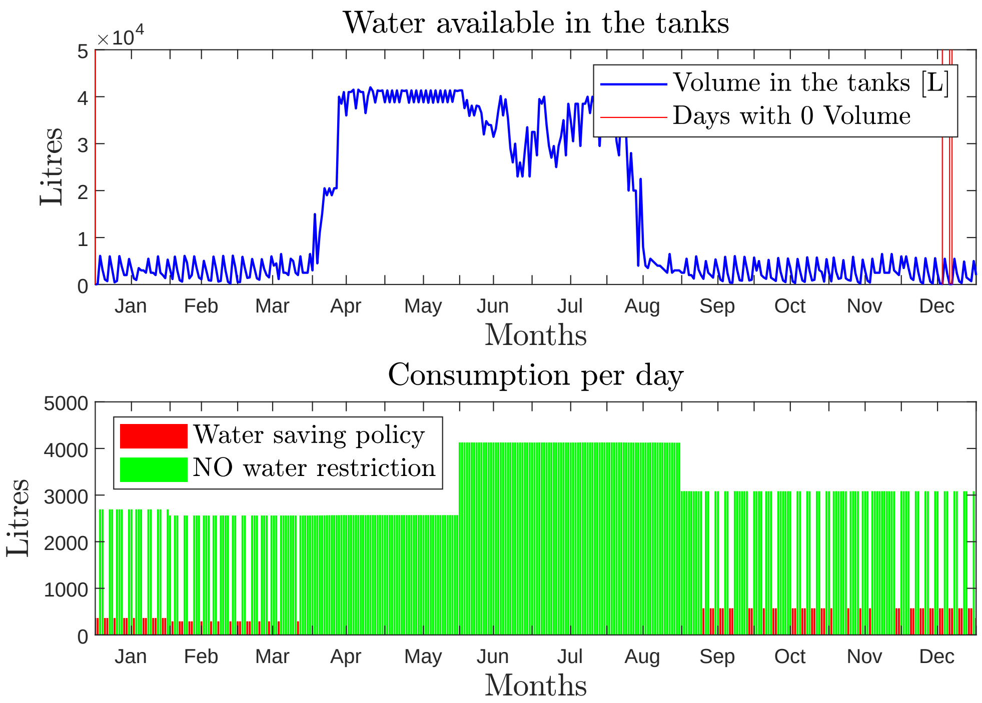

Figure 78: Water recycling from shower

In all this calculations, the maximum capacity of water that can be stored is assumed to be 41350 Litres. This corresponds to the amount including the cement tank that was constructed on Summer 2018, which has not been connected to the rest yet.

Up to this point, the project has only been software development and analysis in order to provide with a sufficiently accurate advisable consumption policy for their available resources. This produces no economical expense.

From now on, further analysis and proposals incur in additional economical costs.

The cost of the main deposit was broken down in Table 7. A total of 2615.22 €were used. According with the budget calculated in Tables 4, 5 and 6, corresponding respectively to arrangements in Figures 60, 61 and 62, the cost of connecting this main tank with the rest of them would be:

- **555.10 €** In the case of a simple connection with the plastic tanks.
- **634.22 €** In the case of a non-automatic or manual water delivery system. Although, with independent connections between the main and secondary deposits.
- **1742.91 €** In the case of an independent connection in each of them with an automatic-emptiness-detecting system that refills them as needed.

In principle, this is the only amount needed for carrying away the project, as the rest of the proposals and problems have been financed already (As solar panels, sewage water treatment plant, construction of the main container...). Therefore, if priorities have to be selected, the first of them would be obtaining previously displayed economical amounts and, depending on the crowd-funding performance, further projects could be financed.

10.1.1 Waste water

Waste water management is the second essential priority. Since there is currently not any filtration or sewage system for waste waters, it is really important to provide with one of the two solutions explained in Section 8.

One of them is the preparation and cleaning of the current water treatment plant (Figure 79). This should not be an expensive or difficult task as it was already used several years ago and all the project building plans and sketches are available. Nevertheless maintenance should be carried away from this moment on in order to ensure it does not stop functioning after a period of time.

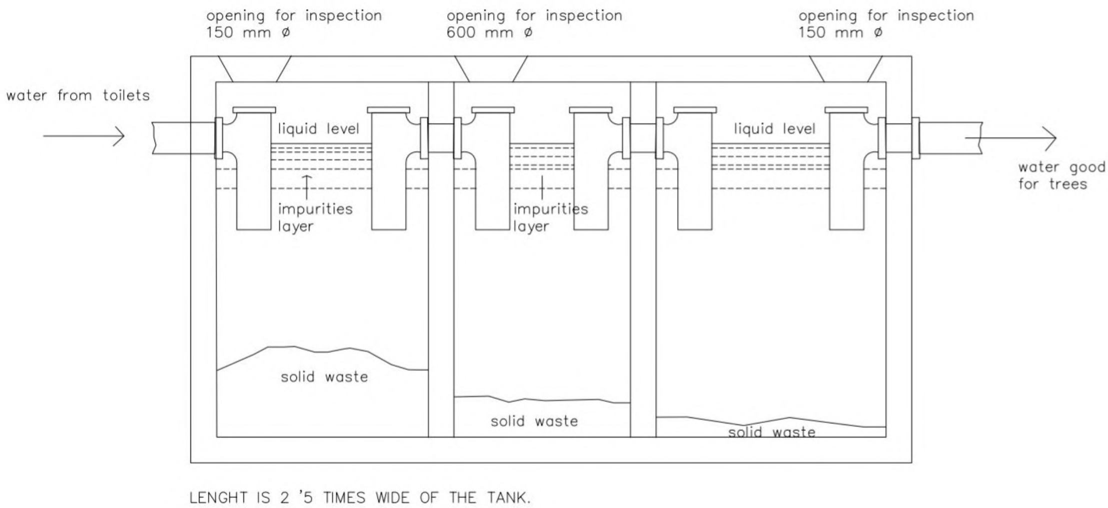

Figure 79: Three stage filtration deposit

The other solution proposed is to construct dynamic lagoons (Figure 80). This idea takes longer until it can be used as the selected plant species have to be grown up before they are able to filtrate the water. Although, it is very cheap as the only required economical expense is buying the plants, which do not have a high cost and the land, which is already acquired.

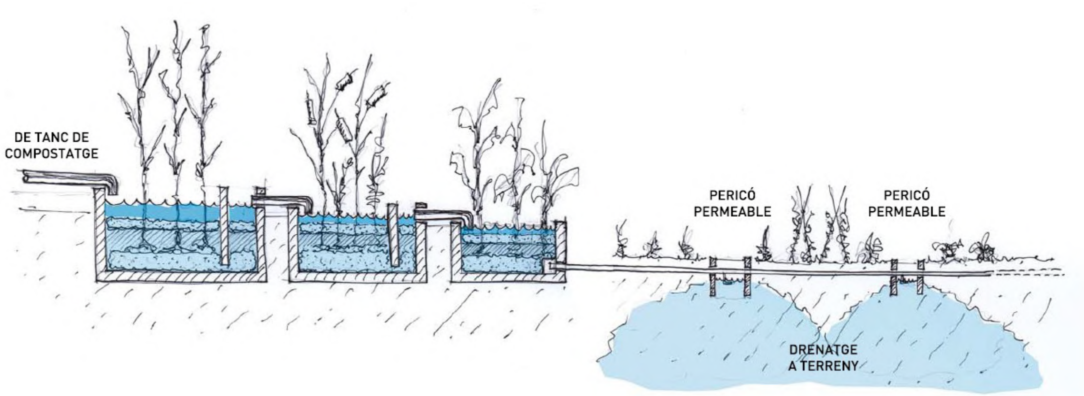

Figure 80: Dynamic lagoons sketch

10.2 Energy proposal

The energy problem has been tackled already in Bamba thank to the contributions to the NGO to buy solar photo-voltaic panels and water heating panels. This has notoriously reduced their electricity consumption and diminish their environmental impact.

Regarding the pump needed to deliver the water from the cement deposit to the rest, it would be really advisable to connect it with this panels. Indeed, in the budget, enough length of cable has been taken into account in the case the energy wants to be brought down to the deposit position.

During the rain season, solar panels might not generate enough energy, nevertheless, it is exactly this time of the year when all tanks should be full or filling up, therefore, carrying the water is not completely neccesary. In the case it has to be done, the fuel pump can be used.

10.3 Overall Budget

This project is composed of three main parts. The construction of the main deposit, the connection with the rest, and the energy supply. Due to the fact that the author started working on it approximately two years ago, some of the parts have already been paid by the NGO members. This is the case of the construction of the cement container and the installation of solar panels.

Fortunately, the only project currently left is the connection. Several different arrangements have been proposed in Section 7.3. The most interesting one is the last one, which offers a completely automatized system that maintains the daily basis used deposits with a higher level than a threshold. Its budget is displayed in Table 6.

If the necessary amount can not be collected, there are other two possible arrangements as seen in Tables 4 and 5.

10.4 Finance

Finally, one of the most important parts of this project will be financing. As it was stated at the start of the essay, the main objective of this thesis is to be, at some stage, brought to life. It is therefore necessary to have one or various sources of funding.

The method that will be used is crowd-funding. As a consequence, the goal is to reach as many people as possible and provide with a **feasible, reliable and promising** project in which is worth investing.

11 Conclusions

Several conclusions have been extracted from this project.

In first place, being aware of the importance of the most valuable resource on Earth: Water. The concern of properly managing and distributing water is our responsibility.

In second place, how education can help people improving their way of living. Thanks to the knowledge obtained in University, students all over the world develop and create innovative projects that help enhance the quality of life of millions of people.

In third place, and more technically, how to use mathematical and computational tools in order to solve real common daily problems. In the current case, familiarizing with numerical methods, statistics, physics, chemistry, calculus...

This subjects have allowed the creation of a Matlab® tool that helps visualizing the importance of certain variables. With this program, the overall income and outcome of water each day of the year can be observed, which, in some cases, could not be possible without it. For example, the influence that it can have in Bamba the small difference between consuming 50 or 70 Litres of water per day. As it was exposed during the project, this can motivate the emptying of the deposits up to two months earlier.

Moreover, it has been learned how to mix several different tools as Euler-Maruyama stochastical method and Monte-Carlo statistical method. Therefore combining both deterministic and stochastic variables.

Furthermore, the study provides with the numerical probability of certain events to occur. This is called Uncertainty Quantification and thanks to this analysis, all possible events, including rare and common ones are taken into account. This is specially important when a set of data does not follow a specific frequent distribution. Using an average or standard deviation would incur in unacceptable numerical errors in the results.

As a consequence of the development of the software, it was seen that, even when the resources seem not to be enough, a correct management and a good consumption policy can provide with very optimistic and realistic results.

An interesting conclusion extracted from this assignment is that creating a cooperation project which can help many people is not necessarily exceedingly expensive. It requires knowledge and effort, but provides back much more than that.

The final conclusion that the author has extracted from this two year project is that it is the students moral duty to share their knowledge and use it to contribute to the progress and development of the humanity. This is why universities play such an important role and should be recognized for it.

Figure 81: Some of the Bamba kids after school

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Annex 1: Interviews

Due to privacy reasons, only some of the interviewed people will be mentioned with their name, nevertheless, all the obtained information will be published as anonymous for everyone who asked not to be named in the project. Moreover, some questions were not answered by some of the interviewees. All questions were proposed to several different people in order to be able to have truthful and contrasted information, avoiding manipulative answers that could be punctually obtained for some personal interests.

Below, every single interviewee answer has been stated with no personal opinions regarding them.

The following signboards refer to the offices where some of the interviews were taken:

Figure 82: Water resources Authorities Offices for Lakes Baringo and Bogoria

Figure 83: Rift Valley water services Board, Baringo regional Office

1. **Personal data:**

   - **Names of interviewed people:**
     Mr. Totona, Mr. Kiplagat, Alice Kibet, Stella Kiptum and 3 anonymous people.

   - **Ages:** 38-53

   - **Charge or occupation:**
     Water management minister of the county, engineers of water management in Kabarnet, technician of Kabarnet storage, Director of water management in Baringo and citizens.

- **Studies:**
  Engineering on water management (kenya Water Institute of Nairobi), engineering on water quality, technician on water resources.

2. **Water resources general questions:**

- **Dry and rain season:**
  Most of the interviewed people answered to this question by stating that usually, rain season starts con March or April and ends on August. Nevertheless, short rains do also appear on the months of September to November. Although, most of the interviewees mentioned that this pattern is inconsistent, as it usually changes significantly from one year to another.

- **Global warming influence:**
  There was several different points of view regarding global warming concept. Some of them stated that the amount of rains has increased and some that it has decreased. Nevertheless, most of them agreed that five to seven years ago the length span of rain season was clearly smaller. Inconsistency regarding the effect of global warming has been found from these answers, therefore, it should be calculated from the obtained rain data. Tendencies should be found for data from 1985 up to 2017.

- **Water sources:**
  The city of Kabarnet is feed by water from Kirandich Dam, which is few kilometres away on a higher elevation. According to the dam Manager, its sources are several rivers (Kaplel, Kmyo, Ngonmek, Terene...). According to him, the excess of water during the rain season leaves to lake Baringo.

  In order to properly manage its water resources, as the local engineers stated, they accumulate water in big storage tanks on a high elevation part of the city to be chlorinated and delivered from there to the citizens. Nevertheless, the workers at the Dam showed the installation from which they obtain hydroelectric energy and treated the water to be in optimum conditions before sending it to the city tanks.

- **Capacity and levels depending on season:**
  Regarding Kirandich Dam, its maximum capacity is roughly 4.000.000 m^3, its level goes down 1.5 metres and its total depth is 52 metres. (With this data and the total surface, assuming a mean depth, the minimum quantity of water during the dry season could be calculated).

  Regarding the city reservoirs, their maximum capacity is 6.000 m^3 and the level during dry season goes down to 500 or 1.000 m^3.

- **Maintenance and inspections:**
  According to the technicians of the Dam, inspections were made mandatory every year. In the case of the local storage deposits, their installation is inspected quarterly.

- **Underground water availability:**
  Most of the interviewed people stated that there is not a way of obtaining underground water. Reasons provided were the following; In first place, the terrain is mostly rocks, which makes it hard and expensive to perforate the ground down to subterranean water bubbles. In second place, the depth is a very important factor as, at small profundities (10-50), bad quality water from lake Baringo is obtained, with a high amount of chemicals as sulphates and nitrates. Due to this it is necessary to dig down to 120-200 m of depth to find drinkable water (Most of the interviewees coincided on this profundities).

  According to the Director of Water Management of Baringo County, the price of a water well, taking into account materials and workforce is around 7000 Kenyan Shillings (KES) per metre deep. Therefore, making a total of 840.000 KES to 1.400.000 KES. In euros, this is approximately 8.000€to 12.500€. But it should be taken into account that the purchasing power in Kenya is much lower than in a European country, which makes this type of constructions mostly impossible if there is not a foreign economical contribution.

3. **Water management:**

   - **Public or private:**
     For the case of the local water management board, it is run by the government, although, several private enterprises take care of some parts of the water delivery. For example, regarding Kirandich Dam, it is Kirandich Water Company LTD who takes care of the water treatment and delivery to the city. Later on, it will be managed by the government with public founding due to the state of the project. As some of the interviewees said, the company is not jest fully developed and due to this, economical help and management from the state is necessary.

   - **Workers and maintenance paid by:**
     Even though the enterprise is owned by the government, it is Kirandich Water Company LTD (KWC) who actually pays the workers and maintenance. Nevertheless, this would not be possible without public subsidies.

4. **Population data:**

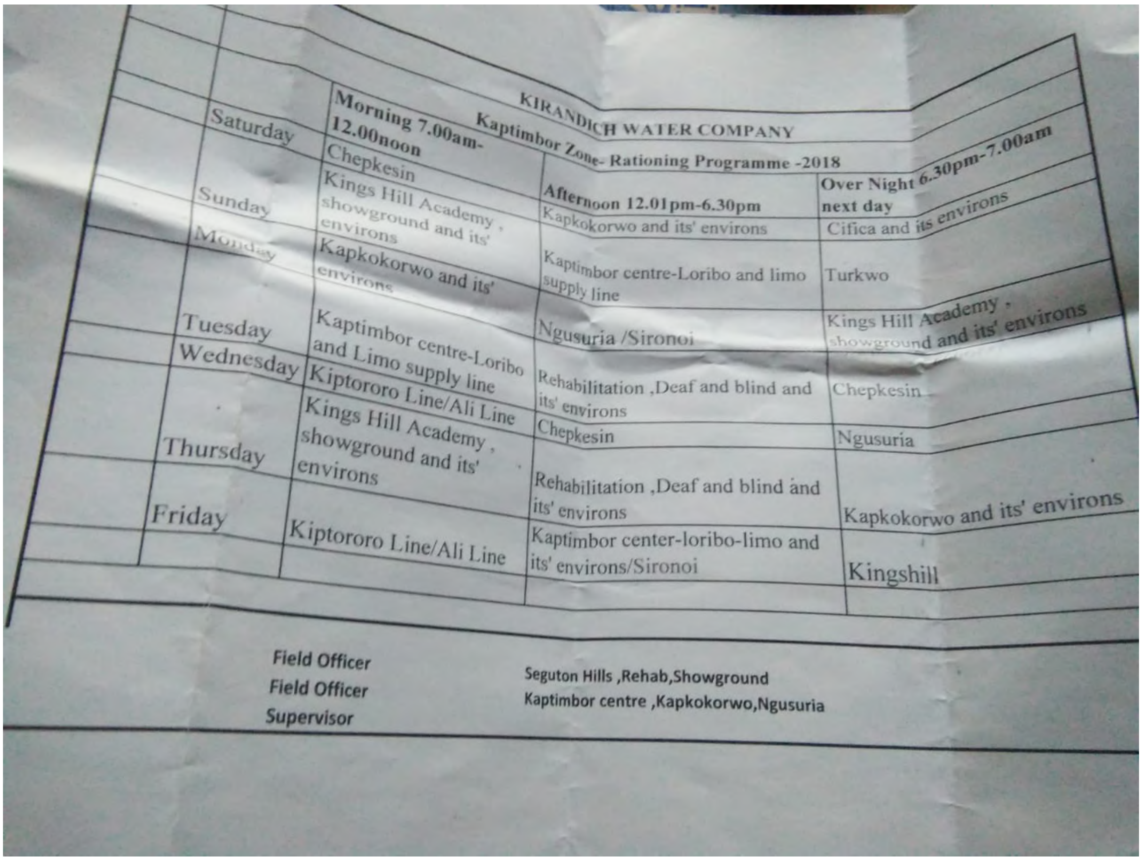
   - **Number of families or houses with access to water:**
     There are around 4000 pipe connections. This is usually, one per house or business. Although, the population of the city is around 24000 people, and increasing. Regarding the whole Kirandich Dam, its design capacity is for 70000 population, as an actual worker on it states.

   - **Maximum water allowance per house:**
     Usually, there is an average of 8h of water available for each house, but this varies from 3-4 as a minimum to 18 maximum. Regarding this question there was some controversy between the actual workers of the company and locals, who state that they do not have the access to that amount of time.

   - **Same for everyone or not:**
     As in previous question, KWC workers state that, in principle, it should be the same for everyone, nevertheless, there is many cases where people or companies that pay more are given privileges regarding the water timetable and the amount of hours they are getting access to water.

   - **Timetable of water delivery:**
     The following timetable[53] provides information about the schedule at which some of the houses of the neighbourhood should be getting access to water. This is done in 8 hour shifts and the one referred to Bamba Home is Kingshill Academy.

[53]The quality of the image is not optimum because it was impossible to scan it. Moreover, making a table out of it would imply loosing credibility.



KIRANDICH WATER COMPANY

Kaptimbor Zone- Rationing Programme -2018

	Morning 7.00am-12.00noon	Afternoon 12.01pm-6.30pm	Over Night 6.30pm-7.00am next day
Saturday	Chepkesin	Kapkokorwo and its' environs	Cifica and its environs
Sunday	Kings Hill Academy , showground and its' environs	Kaptimbor centre-Loribo and limo supply line	Turkwo
Monday	Kapkokorwo and its' environs	Ngusuria /Sironoi	Kings Hill Academy , showground and its' environs
Tuesday	Kaptimbor centre-Loribo and Limo supply line	Rehabilitation ,Deaf and blind and its' environs	Chepkesin
Wednesday	Kiptororo Line/Ali Line	Chepkesin	Ngusuria
Thursday	Kings Hill Academy , showground and its' environs	Rehabilitation ,Deaf and blind and its' environs	Kapkokorwo and its' environs
Friday	Kiptororo Line/Ali Line	Kaptimbor center-loribo-limo and its' environs/Sironoi	Kingshill

Field Officer Seguton Hills ,Rehab,Showground

Field Officer Kaptimbor centre ,Kapkokorwo,Ngusuria

Supervisor

Figure 84: Timetable of water delivery for Bamba neighbourhood

5. **Economical data:**

- **Price of water per litre:**

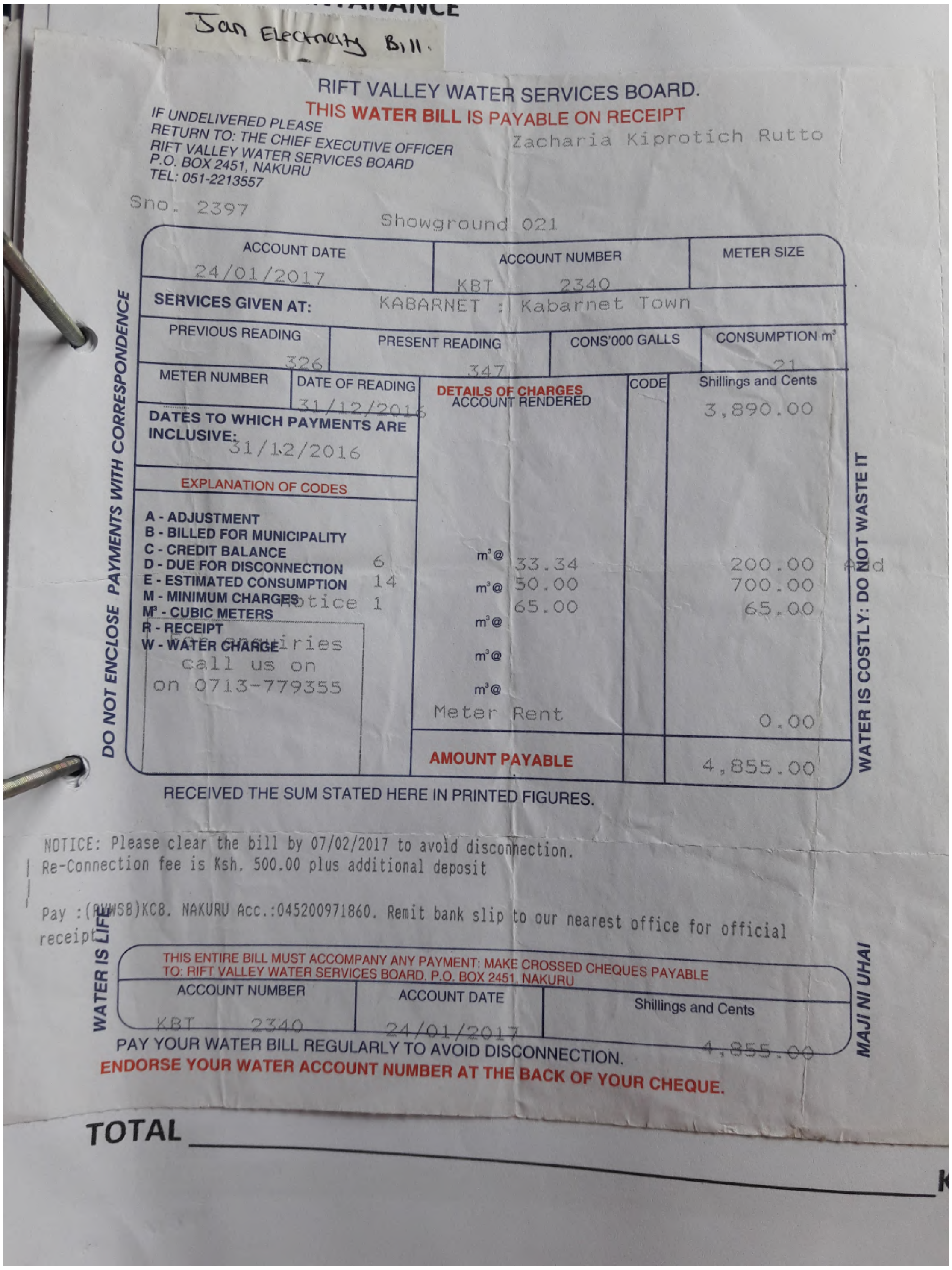
  The price depends on the amount of litres that are being spent: From 0 to 6 m^3 it is 200KSH (around 1.9€). From 6m^3 on, each m^3 costs, 50KSH, 65KSH, 80KSH (0.45€, 0.60€, 0.74€respectively)

- **Changes depending on season:**

  The company states that the price is plain and remains constant along the year, although, some citizens state that they are able to get some water during dry season if they pay extra fees...

- **Tax for water:**

  The tax for the water depends on the amount spent, plus a constant amount for maintenance. As it can be seen on the following bill:



Jan Electricity Bill.

RIFT VALLEY WATER SERVICES BOARD.

THIS WATER BILL IS PAYABLE ON RECEIPT

IF UNDELIVERED PLEASE
RETURN TO: THE CHIEF EXECUTIVE OFFICER
RIFT VALLEY WATER SERVICES BOARD
P.O. BOX 2451, NAKURU
TEL: 051-2213557

Zacharia Kiprotich Rutto

Sno. 2397 Showground 021

ACCOUNT DATE	ACCOUNT NUMBER	METER SIZE
24/01/2017	KBT 2340	

SERVICES GIVEN AT: KABARNET : Kabarnet Town

PREVIOUS READING	PRESENT READING	CONS'000 GALLS	CONSUMPTION m³
326	347		21

METER NUMBER	DATE OF READING	DETAILS OF CHARGES ACCOUNT RENDERED	CODE	Shillings and Cents
	31/12/2016			3,890.00
		m³@ 33.34		200.00
		m³@ 50.00		700.00
		m³@ 65.00		65.00
		m³@		
		m³@		
		m³@		
		Meter Rent		0.00
		AMOUNT PAYABLE		4,855.00

DATES TO WHICH PAYMENTS ARE INCLUSIVE: 31/12/2016

EXPLANATION OF CODES

A - ADJUSTMENT
B - BILLED FOR MUNICIPALITY
C - CREDIT BALANCE
D - DUE FOR DISCONNECTION 6
E - ESTIMATED CONSUMPTION 14
M - MINIMUM CHARGES Notice 1
M³ - CUBIC METERS
R - RECEIPT
W - WATER CHARGE

For enquiries call us on on 0713-779355

DO NOT ENCLOSE PAYMENTS WITH CORRESPONDENCE

WATER IS COSTLY: DO NOT WASTE IT

RECEIVED THE SUM STATED HERE IN PRINTED FIGURES.

NOTICE: Please clear the bill by 07/02/2017 to avoid disconnection.
Re-Connection fee is Ksh. 500.00 plus additional deposit

Pay :(RVWSB)KCB. NAKURU Acc.:045200971860. Remit bank slip to our nearest office for official receipt

WATER IS LIFE

THIS ENTIRE BILL MUST ACCOMPANY ANY PAYMENT: MAKE CROSSED CHEQUES PAYABLE TO: RIFT VALLEY WATER SERVICES BOARD, P.O. BOX 2451, NAKURU

ACCOUNT NUMBER	ACCOUNT DATE	Shillings and Cents
KBT 2340	24/01/2017	4,855.00

MAJI NI UHAI

PAY YOUR WATER BILL REGULARLY TO AVOID DISCONNECTION.

ENDORSE YOUR WATER ACCOUNT NUMBER AT THE BACK OF YOUR CHEQUE.

TOTAL

Figure 85: Example of a Water bill of Bamba

The amount of water spent was 21 m^3, which corresponds to 3.890 KSH. Taxes corresponding to this consumption are a fixed fee of 200KSH and a variable tax of 700 KSH that depends on the consumption.

- **Trucks of additional water:**
  Nearly at any stage of the year it is possible to request for a water truck of variable size

that will go to the water treatment plant of Kirandich Dam and collect water to deliver to your house. Although, the prices for this service are very high and depend on the place your request comes from (due to accessibility problems for a truck). To make an idea, a 12.000 L truck would cost 1.700KSH just for the water, and an extra amount for fuel and delivery, adding up to a total of at least 3.000 to 5.000KSH (more than a whole month of normal use of water).

6. **Practical data:**

- **Pumping system:**
In order to pump water from Kirandich Dam to the city, they use high height pumps that allow for the delivery of water to the surroundings of the city. Once the water arrives to the city tanks, which are above the rest of the houses, it is delivered with the use of gravity force.

- **Water delivery system:**
Several pipes are used to send the water from the main tanks to each house connection. As the interviewees stated, taking into account that the big pipes are underground, usually, the problems of Uncounted Flow of Water (UFW), relate to the several bifurcations of surface small pipes that are close to the house inputs.

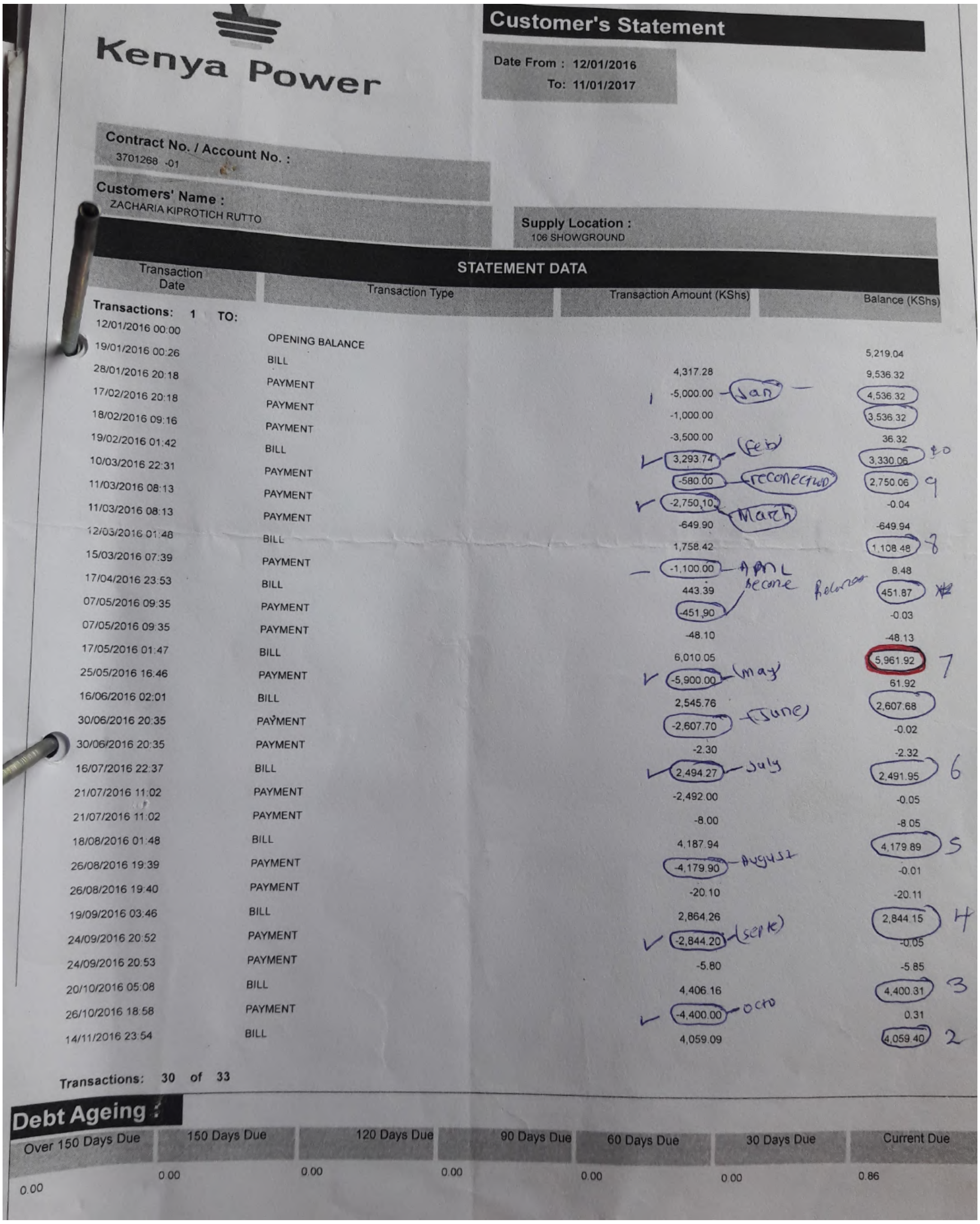
- **Efficiency:**
Most of the interviewed people coincide that efficiency is not the best with the current system due to gravity delivery, which leads to high pressure differences in the houses depending on their height from the main tank, in addition to the leaks from surface pipes.

7. **Enviromental issues:**

- **Water recycling:**
Interviewees state that no one uses water recycling as individuals, but, they assume to re-use water from the showers to some other uses, which is a way of recycling.

- **Sewage water management:**
Depending on the origin of the sewage water the treatment is different. For example; in the case of the hospital, which implies a high risk of disease contagion, **lagoons** are used. For the town buildings, **septic tanks** are used. Finally, for the most part of the people and houses, **pit latrines** is the most common option. Moreover, in big cities where they have more sophisticated sewerage systems, treatment plants are used in order not to release the contaminated waters to the river.

The manager of the NGO also provided us with an electricity bill which corresponds to the year 2017-2018:



Kenya Power

Customer's Statement

Date From : 12/01/2016
To: 11/01/2017

Contract No. / Account No. :
3701268 -01

Customers' Name :
ZACHARIA KIPROTICH RUTTO

Supply Location :
106 SHOWGROUND

STATEMENT DATA

Transactions: 1 TO:

Transaction Date	Transaction Type	Transaction Amount (KShs)		Balance (KShs)	
12/01/2016 00:00	OPENING BALANCE			5,219.04	
19/01/2016 00:26	BILL	4,317.28		9,536.32	
28/01/2016 20:18	PAYMENT	-5,000.00	Jan	4,536.32	
17/02/2016 20:18	PAYMENT	-1,000.00		3,536.32	
18/02/2016 09:16	PAYMENT	-3,500.00		36.32	
19/02/2016 01:42	BILL	3,293.74	(Feb)	3,330.06	10
10/03/2016 22:31	PAYMENT	-580.00	reconection	2,750.06	9
11/03/2016 08:13	PAYMENT	-2,750.10	March	-0.04	
11/03/2016 08:13	PAYMENT	-649.90		-649.94	
12/03/2016 01:48	BILL	1,758.42		1,108.48	8
15/03/2016 07:39	PAYMENT	-1,100.00	April	8.48	
17/04/2016 23:53	BILL	443.39	become Balance	451.87	#
07/05/2016 09:35	PAYMENT	-451.90		-0.03	
07/05/2016 09:35	PAYMENT	-48.10		-48.13	
17/05/2016 01:47	BILL	6,010.05		5,961.92	7
25/05/2016 16:46	PAYMENT	-5,900.00	(may)	61.92	
16/06/2016 02:01	BILL	2,545.76		2,607.68	
30/06/2016 20:35	PAYMENT	-2,607.70	(June)	-0.02	
30/06/2016 20:35	PAYMENT	-2.30		-2.32	
16/07/2016 22:37	BILL	2,494.27	July	2,491.95	6
21/07/2016 11:02	PAYMENT	-2,492.00		-0.05	
21/07/2016 11:02	PAYMENT	-8.00		-8.05	
18/08/2016 01:48	BILL	4,187.94		4,179.89	5
26/08/2016 19:39	PAYMENT	-4,179.90	August	-0.01	
26/08/2016 19:40	PAYMENT	-20.10		-20.11	
19/09/2016 03:46	BILL	2,864.26		2,844.15	4
24/09/2016 20:52	PAYMENT	-2,844.20	(sept)	-0.05	
24/09/2016 20:53	PAYMENT	-5.80		-5.85	
20/10/2016 05:08	BILL	4,406.16		4,400.31	3
26/10/2016 18:58	PAYMENT	-4,400.00	octo	0.31	
14/11/2016 23:54	BILL	4,059.09		4,059.40	2

Transactions: 30 of 33

Debt Ageing :

Over 150 Days Due	150 Days Due	120 Days Due	90 Days Due	60 Days Due	30 Days Due	Current Due
0.00	0.00	0.00	0.00	0.00	0.00	0.86

Figure 86: Electricity bill

Annex 2: Matlab Code

Main Code

```
clc
clear
close all
addpath('Functions','Data')
%% Inputs
global num_it                    %Declaring global variables that will
global count                     %be used further on in functions
global consumed_litres_per_day
consumed_litres_per_day=zeros();
count=1;

Vini=0;

%What is being asked on the Menu?

prompt = {'Enter the number of days to study (from 1 to 366)',...
     'Enter the number of Bins for the probability histogram',...
     'Enter the number of years to compute the probabilities',...
     'Enter the number of ITERATIONS for the Numerical Method'};

%Title of the Menu

dlgtitle = 'Input parameters';
dims = [1 35];

%Predefined input

definput = {'366','4','10','100'};%%,'10'};
parametros_seleccionados = inputdlg(prompt,dlgtitle,dims,definput);
dias=str2double(parametros_seleccionados(1));
nbins=str2double(parametros_seleccionados(2));
NumYears=str2double(parametros_seleccionados(3));
num_it=str2double(parametros_seleccionados(4));

%%%%%%%%%%%%          TIME BAR          %%%%%%%%%%%%
elapsed_time=0;
sec='Calculating...';
message1 = ['Time elapsed : ',num2str(floor(elapsed_time/60)),...
     'min ',num2str(mod(elapsed_time,60)),'sec'];
message2 = ['Time remaining : ',sec];
message ={message1,message2,''};
f = waitbar(0,message,'CreateCancelBtn',...
     'setappdata(gcbf,''canceling'',1)');
setappdata(f,'canceling',0)
%%%%%%%%%%%%          TIME BAR          %%%%%%%%%%%%

%% Obtain volume values along the year for the ith year

prob_vol_dia=zeros(2,nbins,dias);
valores_dia=zeros(NumYears,366);
maxVol=zeros(dias);
```

```
minVol=zeros(dias);
for i=1:NumYears
        tic
  if getappdata(f,'canceling')
       break
  end

    valores_dia(i,:)=RandomYear(Vini);%Store volume value of the water
    time = toc;                       %in the tanks for the ith year
     elapsed_time=(elapsed_time+time);%in matrix valores_dia
     perc = i/NumYears;
     sec=((time*NumYears)-(time*i));
    message1 = ['Time elapsed running code : ',...
        num2str(floor(elapsed_time/60)),'min ',...
        num2str(round(mod(elapsed_time,60))),'sec'];
    message2 = ['Time remaining : ',num2str(floor(sec/60)),...
        'min ',num2str(round(mod(sec,60))),'sec'];
    message ={message1,message2};
    waitbar(perc,f,message)
    %%%%%%%%%%%%          TIME BAR        %%%%%%%%%%%%
end
delete(f)

%%%%%%%%%%%%          TIME BAR        %%%%%%%%%%%%
elapsed_time=0;
sec='Calculating...';
message1 = ['Time elapsed plotting and/or Saving data: ',...
    num2str(floor(elapsed_time/60)),'min ',...
    num2str(mod(elapsed_time,60)),'sec'];
message2 = ['Time remaining : ',sec];
message ={message1,message2,''};
f = waitbar(0,message,'CreateCancelBtn',...
    'setappdata(gcbf,''canceling'',1)');
setappdata(f,'canceling',0)
%%%%%%%%%%%%          TIME BAR        %%%%%%%%%%%%

%% Do the Histogram for the probability taking the total number of
%years selected for computing the probabilities

vol=zeros();
probM=zeros();
volM=zeros();
for i=1:dias
    tic
  if getappdata(f,'canceling')
       break
  end
%Do histogram of volume falues for the selected number of years
[prob,edges]=histcounts(valores_dia(:,i),...
    nbins,'Normalization','probability');
for j=1:nbins
    vol(j)=abs((edges(j+1)-edges(j))/2+edges(j));
end
prob_vol_dia(1,:,i)=prob;
prob_vol_dia(2,:,i)=vol;
for k=1:nbins
```

```
    if vol(k)<0.1
        vol(k)=10;
    end
end

%% Plots

%%%%%%%%%%%    FIGURE    %%%%%%%%%%%%
figure(1)
scatter(zeros(nbins,1)+i,vol,20,prob,'filled','LineWidth',5)
colorbar
set(gca, 'YScale', 'log')
ylim([500,10e4])
xlim([0 dias])
xlabel('Months','interpreter','latex','fontsize',14)
ylabel('Litres','interpreter','latex','fontsize',14)
title('Volume and its corresponding probability',...
    'interpreter','latex','fontsize',14)
xticks([16 32 45 60 74.5 91 105 121 137 152 166,...
    182 198 213 228 244 259 274 289 305 320 335 350 366])
xticklabels({'Jan' '' 'Feb' '' 'Mar' '' 'Apr' '' 'May' '',...
    'Jun' '' 'Jul' '' 'Aug' '' 'Sep' '' 'Oct' '' 'Nov' '' 'Dec' ''})
title(colorbar,'Probability (0 to 1)')
hold on
%%%%%%%%%%%    FIGURE    %%%%%%%%%%%%


%%%%%%%%%%%    FIGURE BEST    %%%%%%%%%%%%
figure(2);
probM(i)=max(prob);
pos=find(probM(i)==prob, 1, 'first' );%cambia algo?
volM(i)=vol(pos);
scatter(i,volM(i),50,probM(i),'filled','LineWidth',5)
colorbar
xlim([0 dias])
xlabel('Months','interpreter','latex','fontsize',14)
ylabel('Litres','interpreter','latex','fontsize',14)
title('Maximum probability volume','interpreter',...
    'latex','fontsize',14)
xticks([16 32 45 60 74.5 91 105 121 137 152 166,...
    182 198 213 228 244 259 274 289 305 320 335 350 366])
xticklabels({'Jan' '' 'Feb' '' 'Mar' '' 'Apr' '' 'May' '',...
    'Jun' '' 'Jul' '' 'Aug' '' 'Sep' '' 'Oct' '' 'Nov' '' 'Dec' ''})
title(colorbar,'Probability (0 to 1)')
hold on
drawnow
%%%%%%%%%%%    FIGURE BEST    %%%%%%%%%%%%

%%%%%%%%%%%        TIME BAR        %%%%%%%%%%%%
time = toc;
     elapsed_time=(elapsed_time+time);
     perc = i/dias;
     sec=((time*dias)-(time*i));
    message1 = ['Time elapsed running code : ',...
        num2str(floor(elapsed_time/60)),...
        'min ',num2str(round(mod(elapsed_time,60))),'sec'];
```

```
    message2 = ['Time remaining : ',...
        num2str(floor(sec/60)),'min ',...
        num2str(round(mod(sec,60))),'sec'];
    message ={message1,message2};
    waitbar(perc,f,message)
%%%%%%%%%%          TIME BAR        %%%%%%%%%%%

    %fprintf('PERCENTAGE complete SAVING and/or PLOTTING is
    %.2f %%, TIME Taken is %d min %d sec and ESTIMATED...
    %time remaining is %d min %d sec.\n',perc*100,...
    %floor(elapsed_time/60),floor(mod(elapsed_time,60)) ,...
    %floor(sec/60),floor(mod(sec,60)))
maxVol(i)=max(vol);
minVol(i)=min(vol);
end

%% Plots

delete(f)
%%%%%%%%%%   FIGURE BEST   %%%%%%%%%%%
% figure(2)
% plot(1:dias,volM,'k','linewidth',0.5)
% figure(1)
% plot(1:dias,maxVol,'k','linewidth',1)
% hold on
% plot(1:dias,minVol,'y','linewidth',1)
%%%%%%%%%%   FIGURE BEST   %%%%%%%%%%%



% Next loop divides the consumption of each day into two vectors, in
%consumed_litres_per_day_WS, days with Water Saving consumption will
%show a value and the rest will have a 0. consumed_litres_per_day_NWS
%shows the value consumed only in the days when the consumption
%policy has not been applied

consumed_litres_per_day_WS=zeros(1,length(consumed_litres_per_day));
consumed_litres_per_day_NWS=zeros(1,length(consumed_litres_per_day));
for i=1:length(consumed_litres_per_day)
    if consumed_litres_per_day(2,i)==true
        consumed_litres_per_day_WS(i)=consumed_litres_per_day(1,i);
    else
        consumed_litres_per_day_NWS(i)=consumed_litres_per_day(1,i);
    end
end


figure(3)
subplot(2,1,1)
plot(1:dias,volM,'b','linewidth',1)
xlabel('Months','interpreter','latex','fontsize',14)
ylabel('Litres','interpreter','latex','fontsize',14)
xlim([1 dias])
ylim([0 50000])
xticks([16 32 45 60 74.5 91 105 121 137 152 166,...
    182 198 213 228 244 259 274 289 305 320 335 350 366])
```

```
xticklabels({'Jan' '' 'Feb' '' 'Mar' '' 'Apr' '' 'May' '',...
    'Jun' '' 'Jul' '' 'Aug' '' 'Sep' '' 'Oct' '' 'Nov' '' 'Dec' ''})
title('Water available in the tanks',...
'interpreter','latex','fontsize',14)
hold on

subplot(2,1,2)
bar(1:count-1,consumed_litres_per_day_WS,'r','linewidth',0.5)
hold on
bar(1:count-1,consumed_litres_per_day_NWS,'g','linewidth',0.5)
xlabel('Months','interpreter','latex','fontsize',14)
ylabel('Litres','interpreter','latex','fontsize',14)
title('Consumption per day','interpreter','latex','fontsize',14)
xticks([16 32 45 60 74.5 91 105 121 137 152 166,...
    182 198 213 228 244 259 274 289 305 320 335 350 366])
xticklabels({'Jan' '' 'Feb' '' 'Mar' '' 'Apr' '' 'May' '',...
    'Jun' '' 'Jul' '' 'Aug' '' 'Sep' '' 'Oct' '' 'Nov' '' 'Dec' ''})
legend('Water saving policy','NO water restriction','interpreter',...
    'latex','fontsize',12,'location','northwest')
xlim([1 dias])
ylim([0 5000])
hold off
%%%%%%%%%%%          3D PLOT          %%%%%%%%%%%%%%
figure(4)
N=size(prob_vol_dia);
X=prob_vol_dia(2,:,:);
X=reshape(X,N(2),N(3));
Z=prob_vol_dia(1,:,:);
Z=reshape(Z,N(2),N(3));
Y=zeros(N(2),N(3));
for i=1:N(3)
    Y(:,i)=i;
end
Z=100*Z;
surf(X,Y,Z)

title('Resultant matrix representation',...
    'Interpreter','latex','fontsize',16)
xlabel('Volume in the tanks [L]',...
    'interpreter','latex','fontsize',16)
ylabel('Months of the year','interpreter',...
    'latex','fontsize',16)
zlabel('Probability [o to 1]','interpreter',...
    'latex','fontsize',16)
yticks([16 32 45 60 74.5 91 105 121 137 152 166,...
    182 198 213 228 244 259 274 289 305 320 335 350 366])
yticklabels({'Jan' '' 'Feb' '' 'Mar' '' 'Apr' '' 'May' '',...
    'Jun' '' 'Jul' '' 'Aug' '' 'Sep' '' 'Oct' '' 'Nov' '' 'Dec' ''})
% cb = colorbar();
% title(cb,'Probability (%)')
% cb.Ruler.Scale = 'log';
% cb.Ruler.MinorTick = 'on';
% s.EdgeColor = 'none';
%%%%%%%%%%%          3D PLOT          %%%%%%%%%%%%%%

%%%%%%%%%%%     EMPTY TANKS CALCULATION     %%%%%%%%%%%
```

```
empty=zeros(1,dias);
for i=1:dias
    if volM(i)<100
        empty(i)=true;
    end
end
B1=sum(empty)-1;
figure(3)
subplot(2,1,1)
hold on
for i=1:366
    if empty(i)==true
        plot([i i],[0 5e4],'r-')
    end
end
% bar(empty*5*10^4,'r')
legend('Volume in the tanks [L]','Days with 0 Volume',...
    'interpreter','latex','fontsize',12)

%%%%%%%%%%%     EMPTY TANKS CALCULATION     %%%%%%%%%%%


%%%%%%%%%%%     CONSUMPTION RESTRICTION CALCULATION     %%%%%%%%%%%

if dias==366
%Next loop calculates the average from all the years of the number
%of days that the consumption restriction had to be used

A=zeros();
for i=1:NumYears
    vec=((i-1)*365+1):i*365;
    A(i)=sum(consumed_litres_per_day(2,vec));
end
B=mean(A);

msg=msgbox(sprintf(['Number of days with water restriction:',...
    '%3.0f \n Number of days with empty tanks: %3.0f \n'],B,B1),...
    'Relevant outputs','help');

end

%%%%%%%%%%%     CONSUMPTION RESTRICTION CALCULATION     %%%%%%%%%%%
```

RandomYear function (Euler Maruyama)

```
%This function takes as input the initial Volume in the tanks on the
%1st ofJanuary (Assumed to be 0) And gives as an output a matrix with
%the total volume in the tanks each day of the year

%This function performs Euler-Maruyama integration


function [VL]=RandomYear(Vini)
n=2;
S=233.5; %Total surface of roof [m^2]

%Declaring volume of the tanks

girls_tank=2000;
boys_tank=2300;
travellers_tank=5000;
home_tank=5000;
kitchen_tank=2300;
cement_tank=24750;
MaxCapacity=girls_tank+boys_tank+travellers_tank+...
    home_tank+kitchen_tank+cement_tank;
gutter_losses=.92;
VL=zeros(1,366);
VL(n-1)=Vini;
for i=1:12
    if i==1||i==3||i==5||i==7||i==8||i==10||i==12 %months with 31 days
        for j=1:31
            m=i;
            d=j;
            [mmc]=integration(m,d);
            [Gov]=government(m,d);
            [E]=expense(m,n,VL);

            %Next loop does the following:
            %if previous day volume is smaller than zero, then
            %add today value and check if it becomes positive, else
            %if it still negative set today volume to zero

            if VL(n-1)<=0
                VL(n)=mmc*S*gutter_losses+Gov-E;
                if VL(n)<=0
                    VL(n)=0;
                end
                if VL(n)>=MaxCapacity
                    VL(n)=MaxCapacity;
                end
            else
                VL(n)=VL(n-1)+mmc*S*gutter_losses-E+Gov;

                %If previous condition is not fulfilled:
                %else substract to previous day today expense
                %then check if it is smaller than zero after
                %consumption if it still negative set today volume to
                %zero, else today value is that one calculated
```

```

                if VL(n)<=0
                    VL(n)=0;
                end

                if VL(n)>=MaxCapacity
                    VL(n)=MaxCapacity;
                end
            end

                n=n+1;
        end
    elseif i==2
        for j=1:28  %February
            m=i;
            d=j;
            [mmc]=integration(m,d);
            [Gov]=government(m,d);
            [E]=expense(m,n,VL);
            if VL(n-1)<=0
                VL(n)=mmc*S*gutter_losses+Gov-E;
                if VL(n)<=0
                    VL(n)=0;
                end

                if VL(n)>=MaxCapacity
                    VL(n)=MaxCapacity;
                end
            else
                VL(n)=VL(n-1)+mmc*S*gutter_losses-E+Gov;
                if VL(n)<=0
                    VL(n)=0;
                end

                if VL(n)>=MaxCapacity
                    VL(n)=MaxCapacity;
                end
            end

                n=n+1;
        end
    else
        for j=1:30  %months with 30 days
            m=i;
            d=j;
            [mmc]=integration(m,d);
            [Gov]=government(m,d);
            [E]=expense(m,n,VL);
            if VL(n-1)<=0
                VL(n)=mmc*S*gutter_losses+Gov-E;
                if VL(n)<=0
                    VL(n)=0;
                end

                if VL(n)>=MaxCapacity
                    VL(n)=MaxCapacity;
```

```
                end
            else
                VL(n)=VL(n-1)+mmc*S*gutter_losses-E+Gov;
                if VL(n)<=0
                    VL(n)=0;
                end

                if VL(n)>=MaxCapacity
                    VL(n)=MaxCapacity;
                end
            end

                n=n+1;
        end
    end
end

end
```

Integration function (Monte Carlo)

```
%This function uses Monte Carlo statistial method to integrate water
%along the year. It takes as an input the day and month of the year
%that is beign studied and gives as an output the mm^2/m^3
%of rain received that day

function [mmc] = integration(m,d)
global num_it
load('data.mat');
Ny = 38;
volume=zeros();
Nr = 0;

%Next loop counts the number of years that had rain on a certain day

for i=1:Ny
    if(selec{i}(d,m) > 0)
        Nr = Nr + 1;
        volume(Nr) = selec{i}(d,m);
    end
end

%This condition sets a logical value that takes TRUE
%when a random value from 0 to 1 is smaller than
%the percentage of days that rained
rain = (rand() < Nr/Ny);

%Only if the value of rain is TRUE, calculations
%to know how much it has rained will be performed.
%If rain is FALSE, rain that day is assumed to be
%zero.

if(rain)

    numbins=5;
    %Do the actual histogram of the rain values taken from data
    [histvalues,vol]=hist(volume,numbins);


%Set limits of the bins in the histogram

half_bin=((vol(2)-vol(1))/2);
xlim=half_bin+vol(numbins);
xlim_min=vol(1)-half_bin;
ylim=max(histvalues);


%Create random values and position them on a graph

for i=1:num_it %Number of iterations, the more, the more precise
               %CHANGE I WHEN COMPUTER IS FAST

rx=rand()*(xlim-xlim_min)+xlim_min;   %random value on the x axis
ry=rand()*ylim;                       %random value on the Y axis

```

```
if rx>=vol(1)-half_bin
    for j=1:numbins

        if rx>=vol(j)-half_bin && rx<=vol(j)+half_bin
            bin=j;

            if ry<histvalues(bin)  %Check if the random value is below
                mmc=rx;            %the real histogram taken from data
            end                    %If it is bigger, go to the next
                                   %iteration
        end
    end
end
end
else
    mmc=0;                         %If a value under the histogram is not
end                                %found within the number of iterations
end                                %select 0

%error('Not able to find a rain value within the given
%histogram for the selected number of iterations')
```

Expense function (Consumption calculation)

```
%This function takes as input m and n, which are the month and the day
%of the year currently studied. The next input is VL, which is the
%volume in the tanks the previous day.
%The function gives as an output the whole amount of water spent
%that day in Litres
function [E]=expense(m,n,VL)
global count
global consumed_litres_per_day
k=0.08;  %percentage lost from carrying the water from the roof
v=1;     %Velocity of the air in contact with the water [m/s] (Nearly
         %0 as it is inside of a tank)
theta=(25+19*v);     %Evaporation coefficient [kg/m^2h]
R=2;     %Radius of the cylindrical tanks
L=5.5;   %Length of the cement tank [m]
W=2.5;   %Width of the cement tank [m]
S_tanks=pi*R^2*5+L*W;   %Total surface of water in contact with air
threshold=1500;      %Minimum water volume for
                     %water saving consumption policy.
E_trav=80;   %Water consumption per traveller per day

%Next if sets the average Number of Travellers per month
%depending on the time at the year


if m<2
    N_trav(m)=3;
    xs=0.027125;
    x=0.015261;
elseif m<6
    N_trav(m)=2;
    xs=0.014659;
    x=0.008542;
elseif m<9
    N_trav(m)=14;
    xs=0.01062;
    x=0.0056318;
elseif m<=12
    N_trav(m)=6;
    xs=0.019826;
    x=0.012364;
end
N_kids=35;                      %Number of kids in the orfanage
N_workers=5;
G_laundry=400+30*N_trav(m);     %Dayly expense for laundry [L]
G_house=200+20*N_trav(m);       %Dayly expense for the house [L]
G_trav=E_trav*N_trav(m);        %Dayly expense for travellers houses [L]
G_kitchen=200+20*N_trav(m);     %Dayly expense for cooking [L]
G_shower=40*N_kids+60*N_workers;%Dayly expense for showers [L]
G_evap=theta*S_tanks*(xs-x)*24/365;%Dayly expense from evaporation [L]
G_lost=(VL(n-1)*k)/365;         %Dayily amount of water lost from
                                %pipes or leaking [L]
G_total=G_laundry+G_house+G_trav+...
    G_kitchen+G_shower+G_evap+G_lost;        %Total dayly expense [L]
G_total_saving=.5*G_house+.75*G_trav+.75*G_kitchen+G_evap+G_lost;
```

```

if VL(n-1)<threshold           %Set a condition for start saving water
    E=G_total_saving;      %(When the tanks have less than a certain
else                       %amount of litres)
    E=G_total;
end
    consumed_litres_per_day(1,count)=E;

    if E==G_total_saving
        consumed_litres_per_day(2,count)=true;
    else
        consumed_litres_per_day(2,count)=false;
    end
count=count+1;
end
```

Government function (Income calculation)

```
%This function takes as input the day and month of the year and gives
%as an output valiable Gov, which is the amount of water received by
%the government

function [Gov]=government(m,d)

%During Dry season they only get water once a week for a mean amount
%of 5000 L
if m<=3 || m>=8
    if d==2 || d==6 || d==10 || d==14 ||...
            d==18 || d==22 || d==26 || d==30
        Gov=6000;
    else
        Gov=0;
    end
else

%During rain season they get water on alternative days
%(one yes one no) for an approximate amount of 5000L
    if mod(d,2)==1
        Gov=6000;
    else
        Gov=0;
    end
end
```

Annex 3: Bamba building diagrams

This information and diagrams were obtained from Architecture and Vision[48].

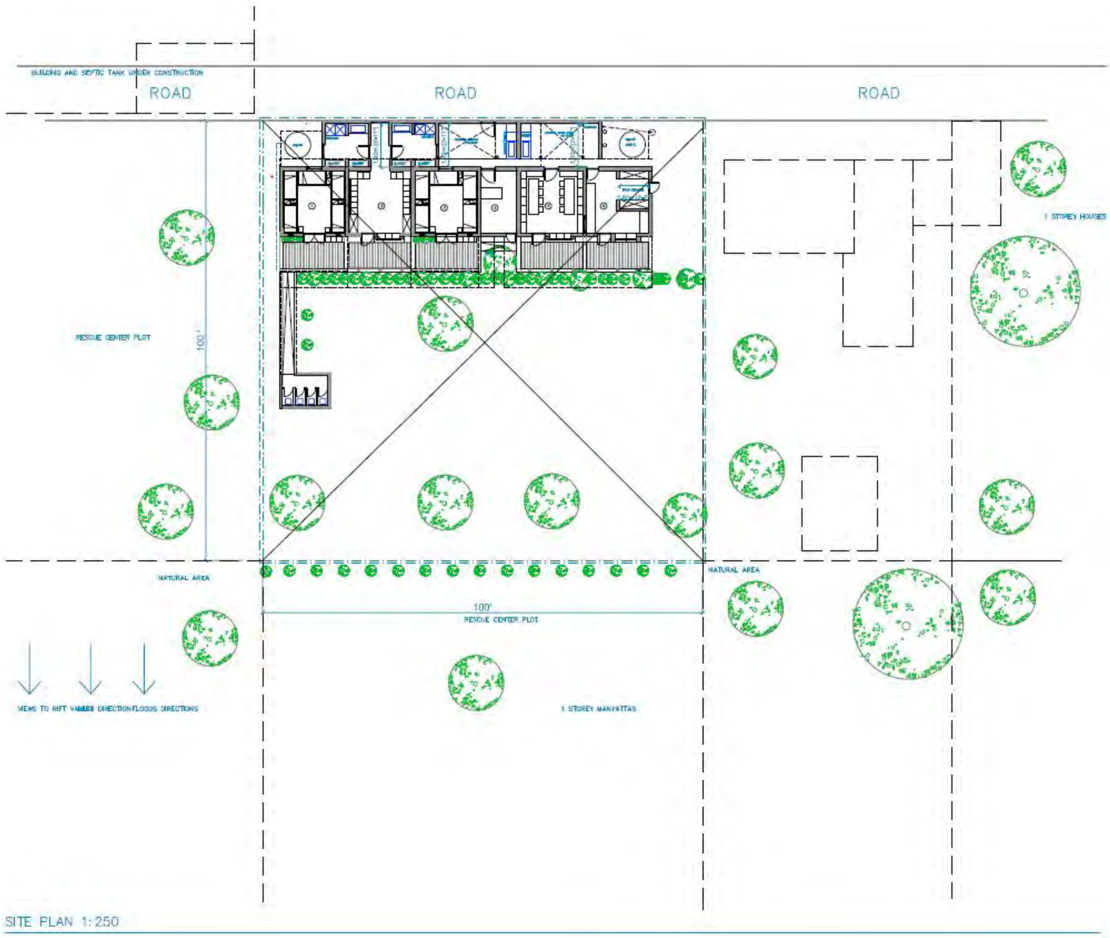


Figure 87: Top view of the field land

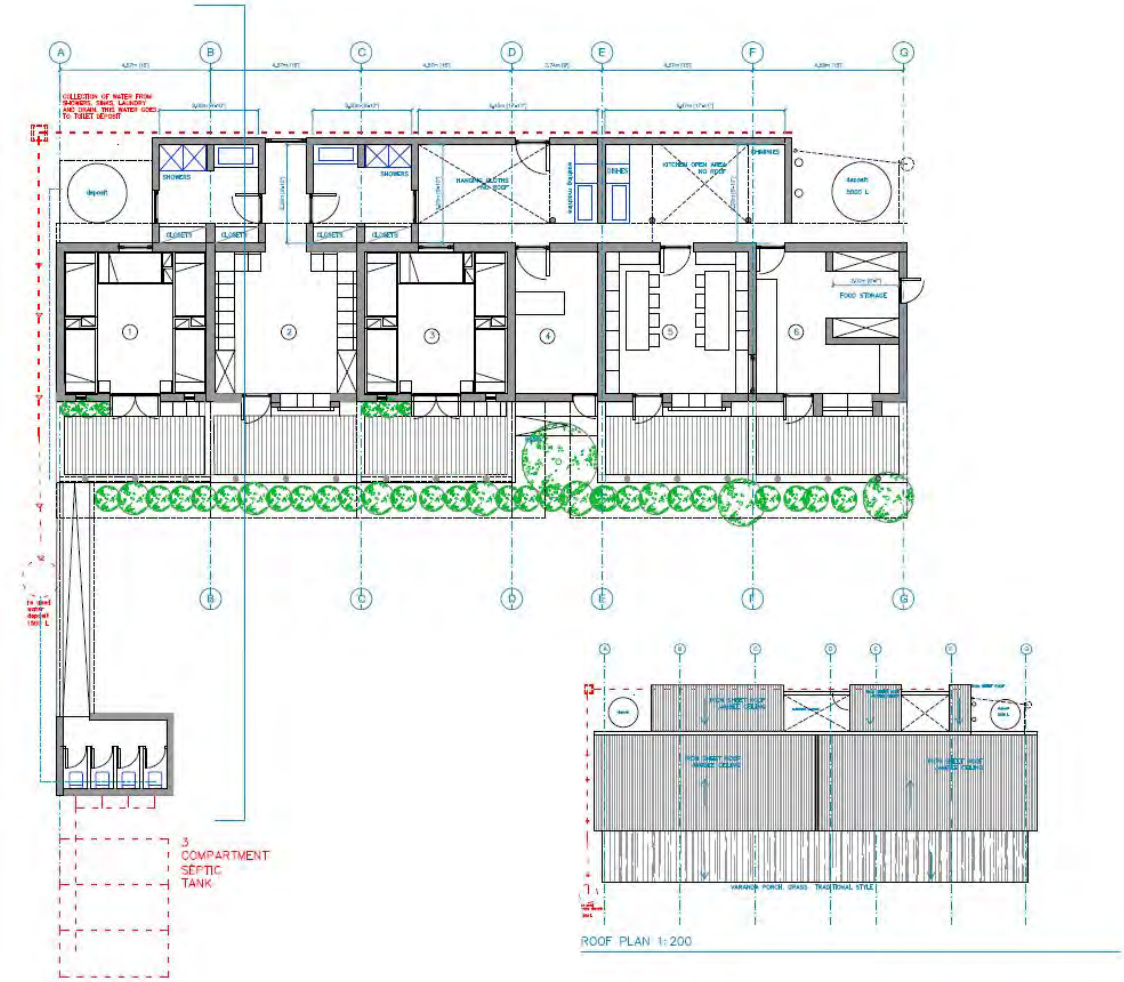


Figure 88: Top view of the main building

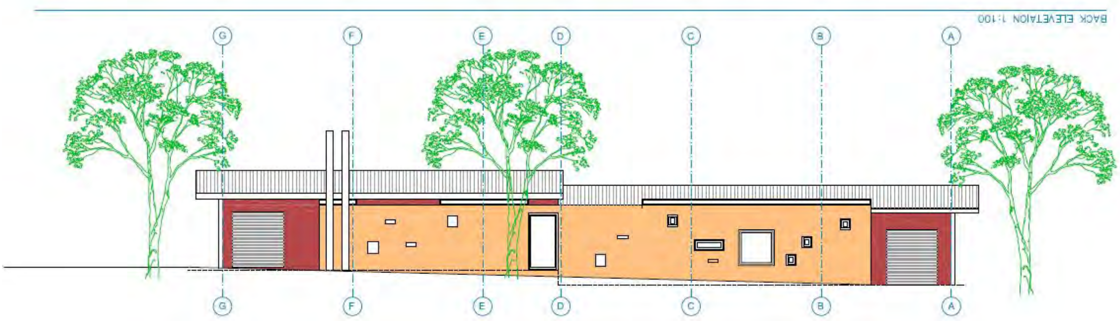


Figure 89: Back view of the main building

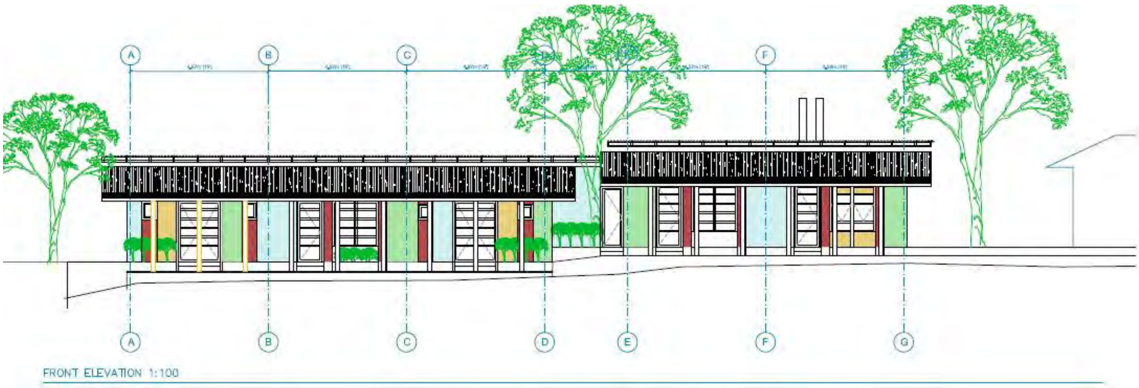


Figure 90: Back view of the main building

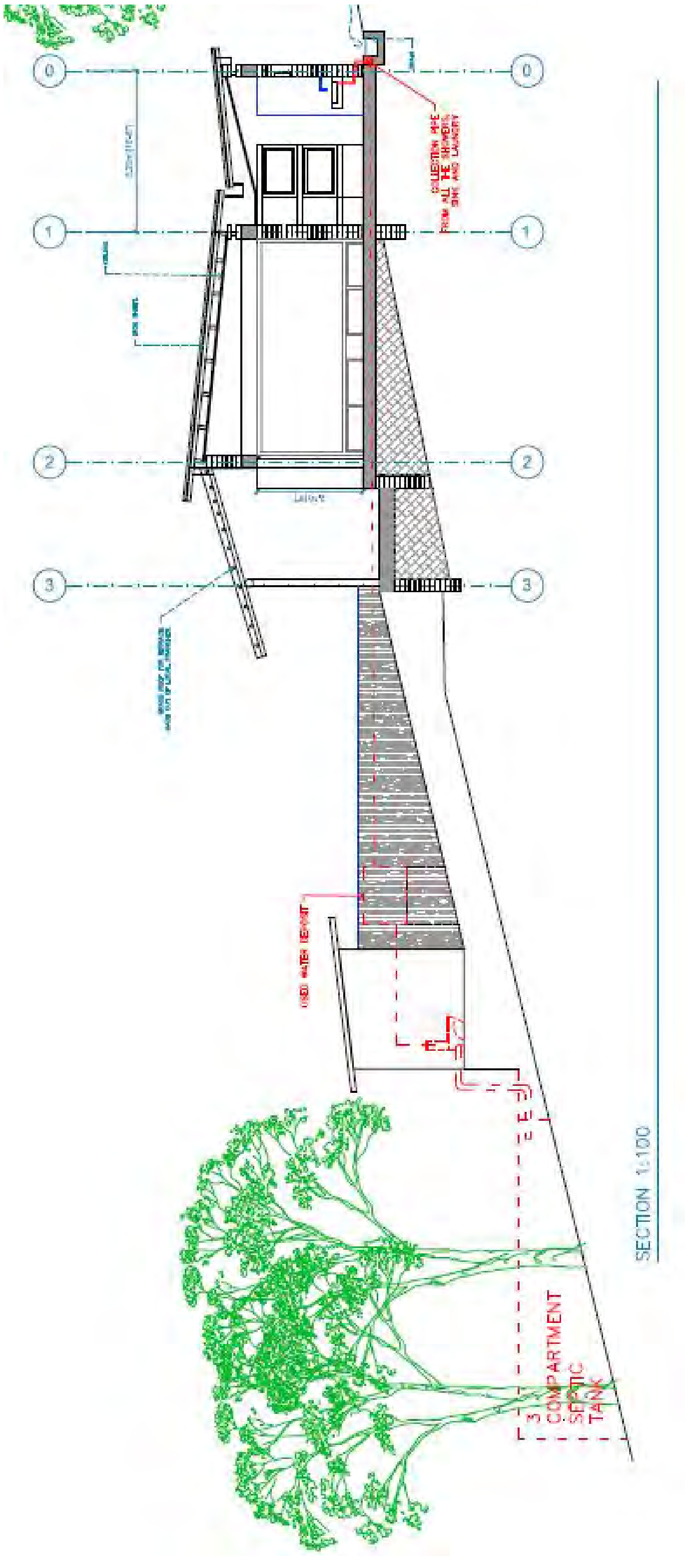


Figure 91: Lateral view of the toilets and deposit

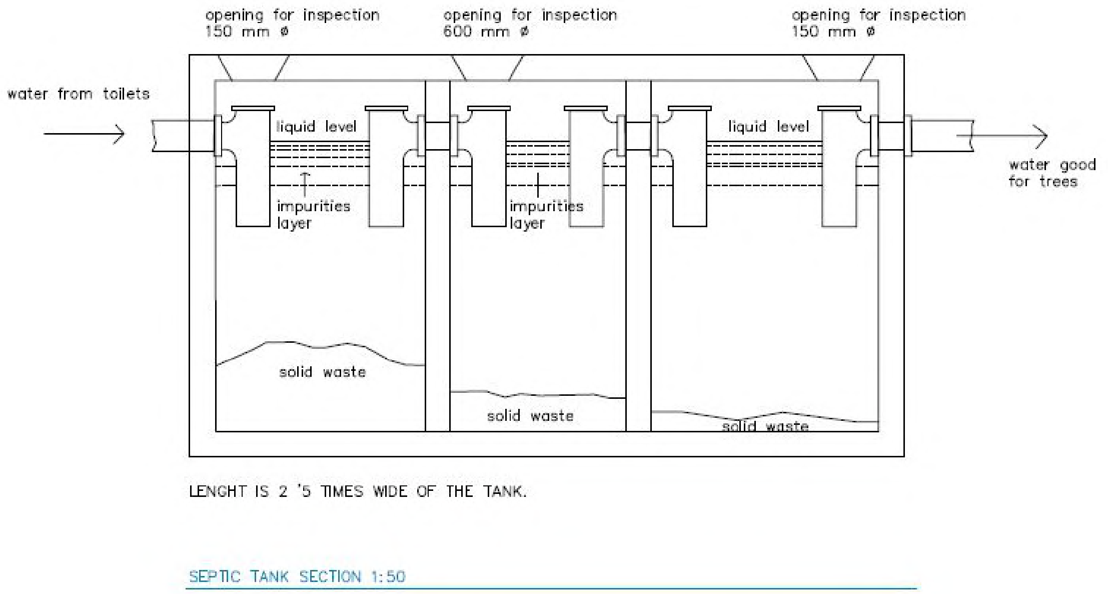


Figure 92: Interior of the treatment plant

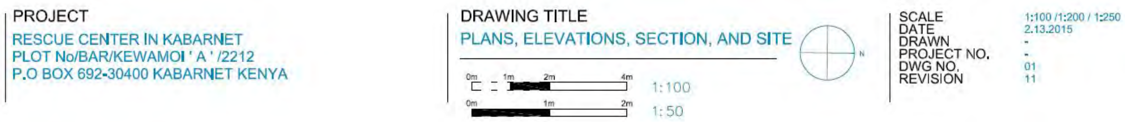


Figure 93: Details of the project and scale

Figure 94: Architect's logo and enterprise

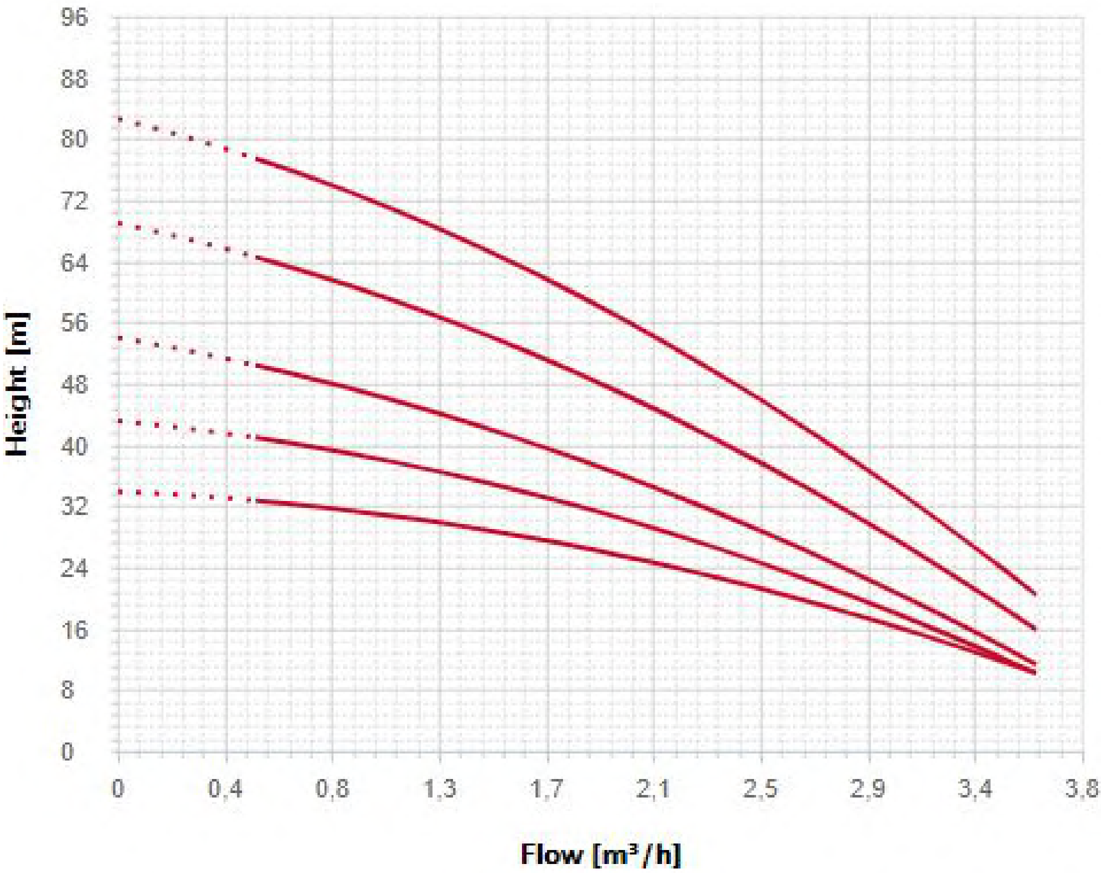
Annex 4: Pump specifications

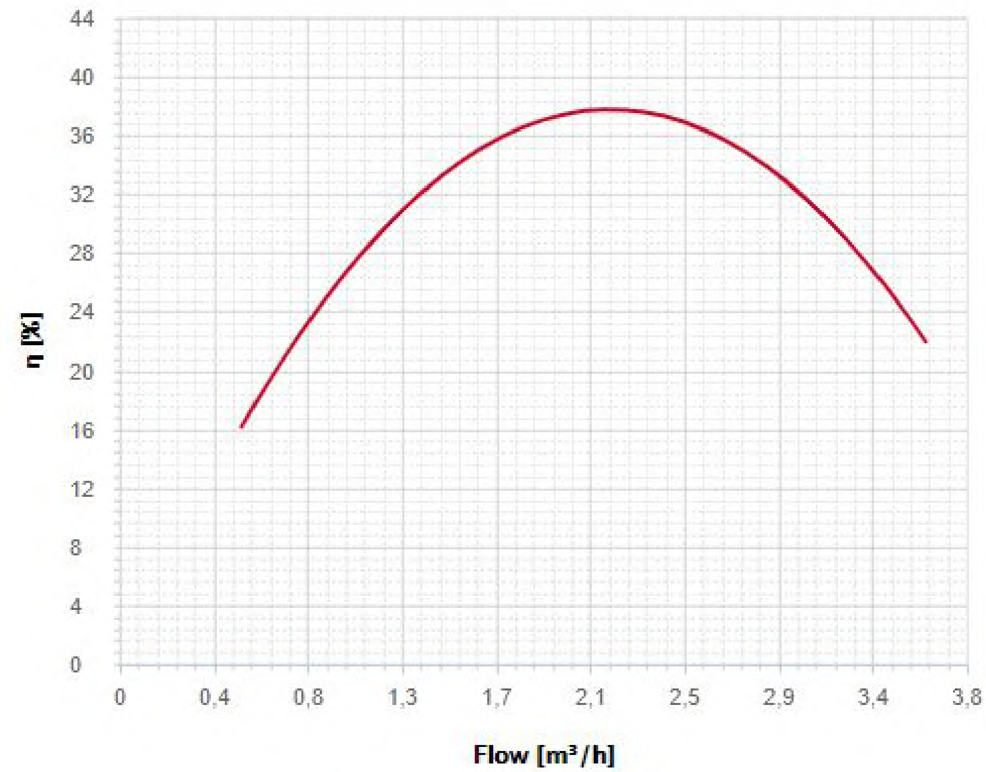
Single-phase models 50 Hz	Three-phase models 50 Hz	Intensity [A] 1~230V	1~220V	3~400V	Input power P1 [kW] 1~	3~	Motor power P2 [kW]	[HP]	Condenser capacity [µF] 1~
ACUARIA07 3M N		2,90			0,65		0,50	0,67	12µF 450V
ACUARIA07 4M N	**ACUARIA07 4 N**	4,00		1,50	0,90	0,80			12µF 450V
ACUARIA07 5M N	**ACUARIA07 5 N**	4,70		2,20	1,00	1,00	1,00	1,34	6+6µF 450V
ACUARIA07 6M N	**ACUARIA07 6 N**	6,20		2,20	1,20	1,10			6+6µF 450V
ACUARIA07 7M N	**ACUARIA07 7 N**	5,50		2,40	1,30	1,30			30µF-450V

Table 8: Electric features

Single-phase models	Three-phase models	Flow [m³/h]	0,0	0,4	0,7	1,1	1,4	1,8	2,2	2,5	2,9	3,2	3,6
ACUARIA07 3M N			34,0	33,3	32,2	30,8	28,9	26,8	24,2	21,3	18,0	14,3	10,2
ACUARIA07 4M N	**ACUARIA07 4 N**		43,2	41,8	40,0	37,8	35,2	32,1	28,6	24,6	20,3	15,5	10,2
ACUARIA07 5M N	**ACUARIA07 5 N**	Height[m]	54,1	51,8	49,1	45,9	42,3	38,2	33,8	28,8	23,5	17,6	11,4
ACUARIA07 6M N	**ACUARIA07 6 N**		69,0	66,2	62,9	59,0	54,5	49,5	43,9	37,7	31,0	23,8	15,9
ACUARIA07 7M N	**ACUARIA07 7 N**		82,7	79,4	75,4	70,8	65,6	59,7	53,2	46,0	38,1	29,6	20,5

Table 9: Hydraulic features





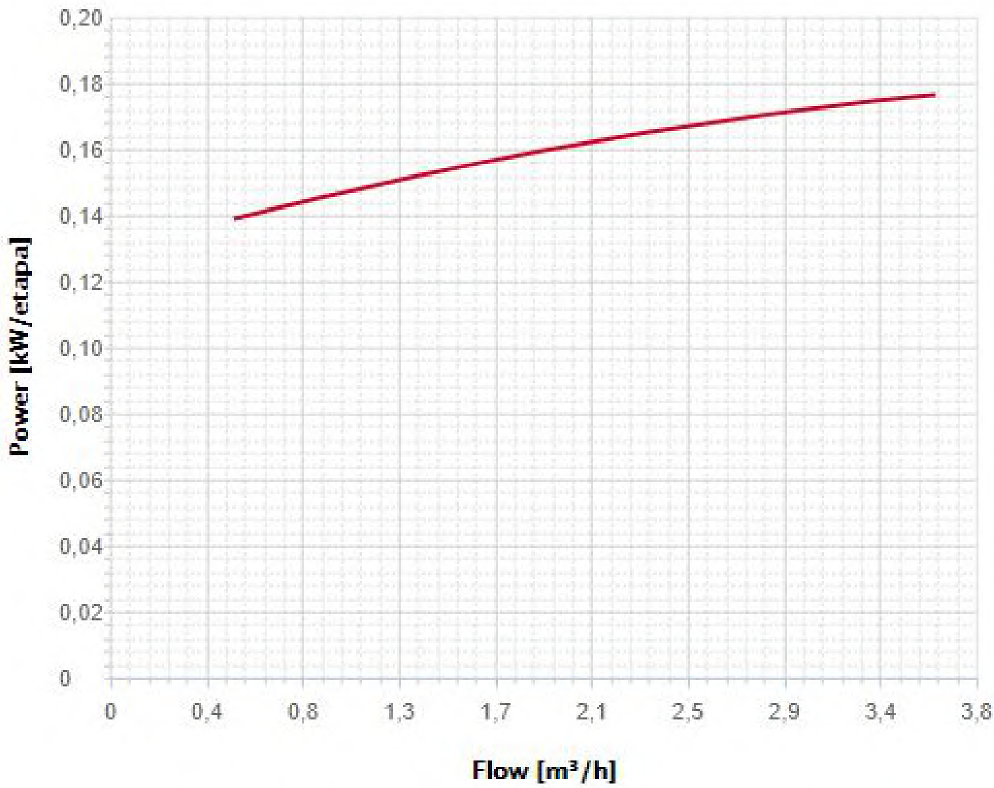


Figure 95: Operating Curves

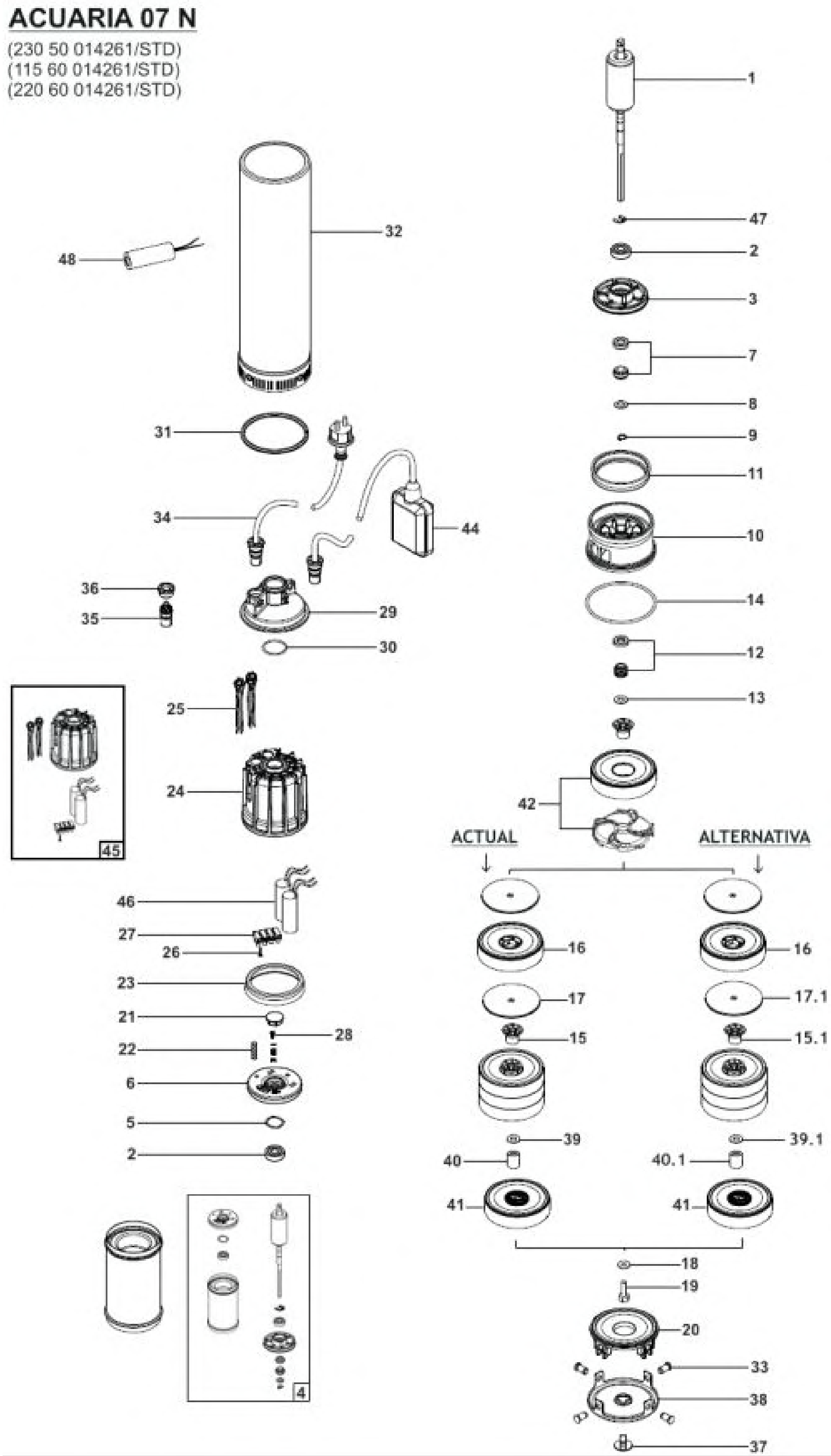


Figure 96: Diagrams

Appendix

Country	Population (1 000s)	Precip Rate1 (mm/yr)	TARWR Volume 2005 (km3/yr)	TARWR Per Capita 2000 (m3/yr)	TARWR Per Capita 2005 (m3/yr)
Afghanistan	24926	300	65	2986	2610
Albania	3194	1000	42	13306	13060
Algeria	32339	100	14	478	440
Angola	14078	1000	148	14009	10510
Antigua and Barbuda	73	2400	0.1	800	710
Argentina	38871	600	814	21981	20940
Armenia	3052	600	10	2780	3450
Aruba	101				
Australia	19913	500	492	25708	24710
Austria	8120	1100	78	9616	9570
Azerbaijan	8447	400	30	3765	3580
Bahamas	317	1300	0.02	66	63
Bahrain	739	100	0	181	157
Bangladesh	149664	2700	1211	8809	8090
Barbados	271	2 100	0.1	307	296
Belarus	9852	600	58	5694	5890
Belgium	10340	800	18	1786	1770
Belize	261	2200	19	82 102	71 090
Benin	6918	1 000	26	3 954	3 820
Bermuda	82	1 500			
Bhutan	2325	1700	95	45564	40860
Bolivia	8973	1100	623	74743	69380

Table 10 continued from previous page

Country	Population (1 000s)	Precip Rate1 (mm/yr)	TARWR Volume 2005 (km3/yr)	TARWR Per Capita 2000 (m3/yr)	TARWR Per Capita 2005 (m3/yr)
Bosnia and Herzegovina	4186	1000	38	9429	8960
Botswana	1795	400	12	9345	6820
Brazil	180654	1800	8233	48314	45570
Brunei Darussalam	366	2700	9	25915	23220
Bulgaria	7829	600	21	2680	2720
Burkina Faso	13393	700	13	1084	930
Burundi	7068	1200	15	566	2190
Cambodia	14482	1900	476	36333	32880
Cameroon	16296	1600	286	19192	17520
Canada	31744	500	2902	94353	91420
Cape Verde	473	400	0.3	703	630
Central African Rep.	3912	1300	144	38849	36910
Chad	8854	300	43	5453	4860
Chile	15996	700	922	60614	57640
China	1320892	600	2830	2259	2140
China, Taiwan Prov.	22894	2400	67		2930
Colombia	44914	2600	2132	50635	47470
Comoros	790	1800	1.2	1700	1520
Congo, Dem Rep.	54417	1500	1283	25183	23580
Congo	3818	1600	832	275679	217920
Costa Rica	4250	2900	112	27932	26450

Table 10 continued from previous page

Country	Population (1 000s)	Precip Rate1 (mm/yr)	TARWR Volume 2005 (km3/yr)	TARWR Per Capita 2000 (m3/yr)	TARWR Per Capita 2005 (m3/yr)
Côte d'Ivoire	16897	1300	81	5058	4790
Croatia	4416	1100	106	22669	23890
Cuba	11328	1300	38	3404	3370
Cyprus	808	500	0.8	995	970
Czech Rep	10226	700	13	1280	1290
Denmark	5375	700	6	1128	1120
Djibouti	712	200	0.3	475	420
Dominica	79	3 400			
Dominican Republic	8872	1400	21	2507	2370
Ecuador	13192	2100	424	34161	32170
Egypt	73390	100	58	859	790
El Salvador	6614	1700	25	4024	3810
Equatorial Guinea	507	2200	26	56893	51280
Eritrea	4297	400	6	1722	1470
Estonia	1308	600	13	9195	9790
Ethiopia	72 420	800	122	1749	1680
Fiji	847	2600	29	35074	33710
Finland	5215	500	110	21268	21090
France	60434	900	204	3439	3370
French Guiana	182	2900	134	812121	736260
French Polynesia	248				

Table 10 continued from previous page

Country	Population (1 000s)	Precip Rate1 (mm/yr)	TARWR Volume 2005 (km3/yr)	TARWR Per Capita 2000 (m3/yr)	TARWR Per Capita 2005 (m3/yr)
Gabon	1351	1800	164	133333	121390
Gambia	1462	800	10	6140	5470
Gaza Strip, Palestinian Territories	1376	300	0	52	41
Georgia	5074	1000	63	12035	12480
Germany	82526	700	154	1878	1870
Ghana	21377	1200	50	2756	2490
Greece	10977	700	74	6998	6760
Greenland	57	600	603	10767857	10578950
Grenada	80	1500			
Guadeloupe	443	200			
Guatemala	12661	2700	111	9773	8790
Guinea	8620	1700	226	27716	26220
Guinea-Bissau	1538	1600	31	25855	20160
Guyana	767	2400	241	316689	314210
Haiti	8437	1400	14	1723	1660
Honduras	7099	2000	96	14949	13510
Hungary	9831	600	104	10433	10580
Iceland	292	1000	170	609319	582190
India	1081229	1100	1897	1880	1750
Indonesia	222611	2700	2838	13381	12750
Iran, Islamic Rep.	69788	200	138	1955	1970

Table 10 continued from previous page

Country	Population (1 000s)	Precip Rate1 (mm/yr)	TARWR Volume 2005 (km3/yr)	TARWR Per Capita 2000 (m3/yr)	TARWR Per Capita 2005 (m3/yr)
Iraq	25856	200	75	3287	2920
Ireland	3999	1100	52	13673	13000
Israel	6560	400	2	276	250
Italy	57346	800	191	3325	3340
Jamaica	2676	2100	10	3651	3510
Japan	127800	1700	430	3383	3360
Jordan	5614	100	1	179	160
Kazakhstan	15403	200	110	6778	7120
Kenya	32420	700	30	985	930
Korea, Dem. People's Rep.	22776	1400	77	3464	3390
Korea, Rep.	47951	1100	70	1491	1450
Kuwait	2595	100	0.02	10	8
Kyrgyzstan	5208	400	21	4182	3950
Lao Peoples Dem. Rep.	5787	1800	334	63184	57640
Latvia	2286	600	35	14642	15510
Lebanon	3708	700	4	1261	1190
Lesotho	1800	800	3	1485	1680
Liberia	3487	2400	232	79643	66530
Libyan Arab Jamahiriya	5659	100	1	113	106
Lithuania	3422	700	25	6737	7280
Luxemburg	459	900	3	7094	6750

Table 10 continued from previous page

Country	Population (1 000s)	Precip Rate1 (mm/yr)	TARWR Volume 2005 (km3/yr)	TARWR Per Capita 2000 (m3/yr)	TARWR Per Capita 2005 (m3/yr)
Macedonia, Fr Yugoslav Rep.	2066	600	6	3147	3100
Madagascar	17901	1500	337	21102	18830
Malawi	12337	1200	17	1528	1400
Malaysia	24876	2900	580	26105	23320
Maldives	328	2000	0.03	103	91
Mali	13409	300	100	8810	7460
Malta	396	400	0.1	129	130
Martinique	395	2600	nd		
Mauritania	2980	100	11	4278	3830
Mauritius	1233	2000	3	1904	2230
Mexico	104931	800	457	4624	4360
Moldova, Rep.	4263	600	12	2712	2730
Mongolia	2630	200	35	13739	13230
Morocco	31064	300	29	971	930
Mozambique	19182	1000	217	11814	11320
Myanmar	50101	2100	1046	21898	20870
Namibia	2011	300	18	10211	8810
Nepal	25725	1300	210	9122	8170
Netherlands	16227	800	91	5736	5610
New Caledonia	233	1500			
New Zealand	3904	1700	327	86554	83760

Table 10 continued from previous page

Country	Population (1 000s)	Precip Rate1 (mm/yr)	TARWR Volume 2005 (km3/yr)	TARWR Per Capita 2000 (m3/yr)	TARWR Per Capita 2005 (m3/yr)
Nicaragua	5597	2400	197	38787	35140
Niger	12415	200	34	3107	2710
Nigeria	127117	1200	286	2514	2250
Norway	4552	1100	382	85478	83920
Oman	2935	100	1	388	340
Pakistan	157315	300	223	2 961	1 420
Panama	3177	2700	148	51814	46580
Papua New Guinea	5836	3100	801	166563	137250
Paraguay	6018	1100	336	61135	55830
Peru	27567	1500	1913	74546	69390
Philippines	81408	2300	479	6332	5 880
Poland	38 551	600	62	1596	1600
Portugal	10072	900	69	6859	6820
Puerto Rico	3898	2100	7	1814	1820
Qatar	619	100	0.1	94	86
Reunion	767	2100	5	6935	6520
Romania	22280	600	212	9445	9510
Russian Federation	142397	500	4507	30980	31650
Rwanda	8481	1200	5	683	610
Saint Helena	5	800			
Saint Kitts and Nevis	42	2100	0	621	560

Table 10 continued from previous page

Country	Population (1 000s)	Precip Rate1 (mm/yr)	TARWR Volume 2005 (km3/yr)	TARWR Per Capita 2000 (m3/yr)	TARWR Per Capita 2005 (m3/yr)
Saint Lucia	150	2300			
Saint Vincent and the Grenadines	121	1600			
Samoa	180	3000			
Sao Tome and Principe	165	2 200	2	15797	13210
Saudi Arabia	24919	100	2.4	118	96
Senegal	10339	700	39	4182	3810
Serbia and Montenegro	10519				19820
Seychelles	82	2000			
Sierra Leone	5168	2500	160	36322	30960
Singapore	4315	2500	0.6	149	139
Slovakia	5407	800	50	9279	9270
Slovenia	1982	1200	32	16031	16080
Solomon Islands	491	3000	45	100000	91040
Somalia	10312	300	14	1538	1380
South Africa	45214	500	50	1154	1110
Spain	41128	600	112	2794	2710
Sri Lanka	19218	1700	50	2642	2600
Sudan	34333	400	65	2074	1880
Suriname	439	2300	122	292566	277900
Swaziland	1083	800	4.5	4876	4160
Sweden	8886	600	174	19679	19580

Table 10 continued from previous page

Country	Population (1 000s)	Precip Rate1 (mm/yr)	TARWR Volume 2005 (km3/yr)	TARWR Per Capita 2000 (m3/yr)	TARWR Per Capita 2005 (m3/yr)
Switzerland	7164	1500	54	7462	7470
Syrian Arab Rep.	18223	300	26	1622	1440
Tajikistan	6298	500	16	2625	2540
Tanzania	37671	1100	91	2591	2420
Thailand	63465	1600	410	6527	6460
Togo	5017	1200	15	3247	2930
Tonga	105	2000			
Trinidad and Tobago	1307	1800	3.8	2968	2940
Tunisia	9937	300	4.6	482	460
Turkey	72320	600	214	3439	2950
Turkmenistan	4940	200	25	5218	5000
Uganda	26699	1200	66	2833	2470
Ukraine	48151	600	140	2815	2900
United Arab Emirates	3051	100	0.2	58	4 900
United Kingdom	59648	1200	147	2465	2460
United States of America	297043	700	3051	10837	10 270
Uruguay	3439	1300	139	41654	40420
Uzbekistan	26479	200	50	2 026	1 900
Venezuela, Bolivarian Rep.	26170	1900	1233	51021	47120
Viet Nam	82481	1800	891	11406	10810
West Bank, Palestinian Territories	2386		0.8		320

Table 10 continued from previous page

Country	Population (1 000s)	Precip Rate1 (mm/yr)	TARWR Volume 2005 (km3/yr)	TARWR Per Capita 2000 (m3/yr)	TARWR Per Capita 2005 (m3/yr)
Yemen	20733	200	4	223	198
Zambia	10924	1000	105	10095	9630
Zimbabwe	12932	700	20	1584	1550

Table 10: World rain Data according to the Food and Agriculture Organization of the United Nations [15]

Country	Surface water % TARWR	Ground water % TARWR	Overlap % TARWR	Incoming Waters % TARWR	Outgoing Waters % TARWR	Total Use Waters % TARWR
Afghanistan				15%	77%	36%
Albania	55%	15%	6%	35%	0%	4%
Algeria	12%	92%	6%	3%	3%	42%
Angola	98%	39%	21%	0%	80%	0.20%
Antigua and Barbuda				0%	0%	
Argentina	34%	16%	16%	66%	14%	4%
Armenia	60%	40%	13%	14%	31%	28%
Aruba						
Australia	89%	15%	4%	0%	0%	5%
Austria	71%	8%	8%	29%	100%	3%
Azerbaijan	20%	22%	14%	73%		57%
Bahamas	nd	nd	nd	0%	0%	
Bahrain	3%	0%	0%	97%	0%	258%
Bangladesh	7%	2%	0%	91%	0%	7%
Barbados	10%	92%	2%	0%	0%	105%
Belarus	64%	31%	31%	36%	96%	5%
Belgium	66%	5%	5%	34%	60%	
Belize				14%	0%	1%
Benin	38%	7%	6%	61%	22%	1%
Bermuda						
Bhutan	100%	0%	95%	0.40%		
Bolivia	45%	21%	17%	51%	93%	0.20%

Table 11 continued from previous page

Country	Surface water % TARWR	Ground water % TARWR	Overlap % TARWR	Incoming Waters % TARWR	Outgoing Waters % TARWR	Total Use Waters % TARWR
Bosnia and Herzegovina					100%	
Botswana	7%	14%	1%	80%	5%	1%
Brazil	66%	23%	23%	34%	6%	1%
Brunei Darussalam	100%	1%	1%	0%	0%	
Bulgaria	94%	30%	26%	1%	92%	49%
Burkina Faso	64%	76%	40%	0%	100%	6%
Burundi	65%	48%	48%	35%	14%	2%
Cambodia	24%	4%	3%	75%	99%	1%
Cameroon	94%	35%	33%	4%	14%	0.30%
Canada	98%	13%	12%	2%	5%	2%
Cape Verde	60%	40%	0%	0%	0%	9%
Central African Rep.	98%	39%	39%	2%	98%	0.02%
Chad	31%	27%	23%	65%	9%	0.50%
Chile	96%	15%	15%	4%	0%	1.40%
China	96%	29%	26%	1%	25%	
China, Taiwan Prov.	94%	6%	0%	0%		
Colombia	99%	24%	24%	1%	50%	1%
Comoros	17%	83%	0%	0%	0%	
Congo, Dem Rep.	70%	33%	33%	30%	0%	0.03%
Congo	27%	24%	24%	73%	23%	0.01%
Costa Rica	67%	33%	0%	0%	7%	2%

Table 11 continued from previous page

Country	Surface water % TARWR	Ground water % TARWR	Overlap % TARWR	Incoming Waters % TARWR	Outgoing Waters % TARWR	Total Use Waters % TARWR
Côte d'Ivoire	91%	47%	43%	5%	15%	1%
Croatia	26%	10%	0%	64%	38%	
Cuba	83%	17%	0%	0%	0%	22%
Cyprus	72%	53%	24%	0%	0%	31%
Czech Rep	100%	11%	11%	0%	100%	20%
Denmark	62%	72%	33%	0%	0%	21%
Djibouti	100%	5%	5%	0%	0%	3%
Dominica						
Dominican Republic	100%	56%	56%	0%	5%	16%
Ecuador	102%	32%	32%	0%	36%	4%
Egypt	1%	2%	0%	97%	0%	118%
El Salvador	70%	24%	24%	30%	0%	5%
Equatorial Guinea	96%	38%	35%	0%	0%	0.40%
Eritrea				56%	35%	5%
Estonia	91%	31%	23%	1%	3%	1%
Ethiopia	16%	100%	16%	0%	80%	2%
Fiji				0%	0%	0.20%
Finland	97%	2%	2%	3%	25%	2%
France	87%	49%	48%	12%	7%	20%
French Guiana				0%	0%	
French Polynesia						

Table 11 continued from previous page

Country	Surface water % TARWR	Ground water % TARWR	Overlap % TARWR	Incoming Waters % TARWR	Outgoing Waters % TARWR	Total Use Waters % TARWR
Gabon	99%	38%	37%	0%	0%	0%
Gambia	38%	6%	6%	63%	0%	0.4%
Gaza Strip, Palestinian Territories	0%	82%	0%	18%	0%	
Georgia	90%	27%	25%	8%	19%	6%
Germany	69%	30%	29%	31%	59%	31%
Ghana	55%	49%	47%	43%	0%	1%
Greece	75%	14%	11%	22%	2%	10%
Greenland				0%	0%	
Grenada						
Guadeloupe						
Guatemala	91%	30%	23%	2%	47%	2%
Guinea	100%	17%	17%	0%	45%	1%
Guinea-Bissau	39%	45%	32%	48%	0%	0.4%
Guyana	100%	43%	43%	0%	0%	1%
Haiti	77%	15%	0%	7%	0%	7%
Honduras	91%	41%	31%	0%	0%	1%
Hungary	6%	6%	6%	94%	100%	7%
Iceland	98%	14%	12%	0%	0%	0.1%
India	64%	22%	20%	34%	68%	34%
Indonesia	98%	16%	14%	0%	0%	3%
Iran, Islamic Rep.	71%	36%	13%	7%	7%	53%

Table 11 continued from previous page

Country	Surface water % TARWR	Ground water % TARWR	Overlap % TARWR	Incoming Waters % TARWR	Outgoing Waters % TARWR	Total Use Waters % TARWR
Iraq	45%	2%	0%	53%		57%
Ireland	93%	21%	19%	6%	0%	2%
Israel	15%	30%	0%	55%		122%
Italy	89%	22%	16%	5%	0%	23%
Jamaica	59%	41%	0%	0%	0%	4%
Japan	98%	6%	4%	0%	0%	21%
Jordan	45%	57%	25%	23%		115%
Kazakhstan	63%	6%	0%	31%		32%
Kenya	57%	10%	0%	33%	30%	5%
Korea, Dem. People's Rep.	86%	17%	16%	13%	6%	12%
Korea, Rep.	89%	19%	15%	7%		27%
Kuwait	0%	0%	0%	100%	0%	2227%
Kyrgyzstan	214%	66%	54%	0%	36%	49%
Lao Peoples Dem. Rep.	57%	11%	11%	43%	100%	1%
Latvia	47%	6%	6%	53%	2%	1%
Lebanon	93%	73%	57%	1%	11%	31%
Lesotho	173%	17%	17%	0%	57%	2%
Liberia	86%	26%	26%	14%	0%	0.05%
Libyan Arab Jamahiriya	33%	83%	17%	0%	117%	802%
Lithuania	62%	5%	4%	38%	20%	1%
Luxemburg	32%	3%	3%	68%	100%	

Table 11 continued from previous page

Country	Surface water % TARWR	Ground water % TARWR	Overlap % TARWR	Incoming Waters % TARWR	Outgoing Waters % TARWR	Total Use Waters % TARWR
Macedonia, Fr Yugoslav Rep.	84%	0%	0	16%	100%	
Madagascar	99%	16%	15%	0%	0%	4%
Malawi	93%	8%	8%	7%	93%	6%
Malaysia	98%	11%	9%	0%	0%	2%
Maldives	0%	100%	0%	0%	0%	
Mali	50%	20%	10%	40%	52%	7%
Malta	1%	99%	0%	0%	0%	110%
Martinique						
Mauritania	1%	3%	0%	96%	0%	15%
Mauritius	86%	32%	18%	0%	0%	22%
Mexico	79%	30%	20%	11%	0%	17%
Moldova, Rep.	9%	3%	3%	91%	85%	20%
Mongolia	94%	18%	11%	0%	76%	1%
Morocco	76%	34%	10%	0%	1%	44%
Mozambique	45%	8%	6%	54%	0%	0.3%
Myanmar	84%	15%	14%	16%	5%	3%
Namibia	23%	12%	0%	66%	72%	2%
Nepal	94%	10%	10%	6%	100%	5%
Netherlands	12%	5%	5%	88%	0%	9%
New Caledonia						
New Zealand	0%	0%	1%			

Table 11 continued from previous page

Country	Surface water % TARWR	Ground water % TARWR	Overlap % TARWR	Incoming Waters % TARWR	Outgoing Waters % TARWR	Total Use Waters % TARWR
Nicaragua	94%	30%	28%	4%	0%	1%
Niger	3%	7%	0%	90%	96%	6%
Nigeria	75%	30%	28%	23%	0%	3%
Norway	98%	25%	24%	0%	3%	1%
Oman	94%	97%	91%	0%	0%	137%
Pakistan	21%	25%	22%	76%	3%	76%
Panama	97%	14%	12%	0%	0%	1%
Papua New Guinea	100%			0%	0%	0.01%
Paraguay	28%	12%	12%	72%	99%	0.1%
Peru	84%	16%	16%	16%	94%	1%
Philippines	93%	38%	30%	0%	0%	6%
Poland	86%	20%	19%	13%	3%	26%
Portugal	55%	6%	6%	45%	0%	16%
Puerto Rico				0%	0%	
Qatar	2%	94%	0%	4%	0%	554%
Reunion	90%	56%	46%	0%	0%	
Romania	20%	4%	4%	80%	0%	11%
Russian Federation	90%	17%	11%	4%	0%	2%
Rwanda	100%	69%	69%	0%	81%	1%
Saint Helena						
Saint Kitts and Nevis	15%	85%	0%	0%	0%	

Table 11 continued from previous page

Country	Surface water % TARWR	Ground water % TARWR	Overlap % TARWR	Incoming Waters % TARWR	Outgoing Waters % TARWR	Total Use Waters % TARWR
Saint Lucia						
Saint Vincent and the Grenadines						
Samoa						
Sao Tome and Principe				0%	0%	
Saudi Arabia	92%	92%	83%	0%	6%	722%
Senegal	60%	19%	13%	33%	14%	4%
Serbia and Montenegro	20%	1	1	79%		
Seychelles						
Sierra Leone	94%	31%	25%	0%	0%	0.20%
Singapore				0%	0%	
Slovakia	25%	3%	3%	75%	27%	
Slovenia	58%	42%	42%	41%	60%	
Solomon Islands				0%	0%	
Somalia	40%	23%	21%	56%	0%	23%
South Africa	86%	10%	6%	10%	19%	31%
Spain	98%	27%	25%	0%	31%	32%
Sri Lanka	98%	16%	14%	0%	0%	25%
Sudan	43%	11%	8%	77.00%	30%	58%
Suriname	72%	66%	66%	28%	0%	1%
Swaziland				41%	100%	18%
Sweden	98%	11%	11%	2%	2%	2%

Table 11 continued from previous page

Country	Surface water % TARWR	Ground water % TARWR	Overlap % TARWR	Incoming Waters % TARWR	Outgoing Waters % TARWR	Total Use Waters % TARWR
Switzerland	76%	5%	5%	24%	76%	5%
Syrian Arab Rep.	18%	16%	8%	80%	119%	76%
Tajikistan	396%	38%	19%	17%		75%
Tanzania	88%	33%	31%	10%	14%	2%
Thailand	48%	10%	7%	49%	79%	21%
Togo	73%	39%	34%	22%	54%	1%
Tonga					0%	
Trinidad and Tobago				0%	0%	8%
Tunisia	68%	32%	9%	9%	4%	60%
Turkey	87%	32%	13%	1%	29%	18%
Turkmenistan	4%	1%	0%	97%		100%
Uganda	59%	44%	44%	41%	56%	0%
Ukraine	36%	14%	12%	62%	22%	27%
United Arab Emirates	100%	80%	80%	0%	0%	1538%
United Kingdom	98%	7%	6%	1%	0%	6%
United States of America				8%		16%
Uruguay	42%	17%	17%	58%	0%	2%
Uzbekistan	19%	17%	4%	77%		116%
Venezuela, Bolivarian Rep.	57%	18%	17%	41%	6%	1%
Viet Nam	40%	5%	4%	59%	4%	8%
West Bank, Palestinian Territories	10%	90%	0%	0%	28%	

Table 11 continued from previous page

Country	Surface water % TARWR	Ground water % TARWR	Overlap % TARWR	Incoming Waters % TARWR	Outgoing Waters % TARWR	Total Use Waters % TARWR
Yemen	98%	37%	34%	0%	0%	162%
Zambia	76%	45%	45%	24%	100%	2%
Zimbabwe	66%	25%	20%	39%	71%	13%

Table 11: World rain Data in % according to the Food and Agriculture Organization of the United Nations [15]

YEAR 1980 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	0,7	0,0	0,0	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,0	0,0	0,0	4,3	0,0	0,0	0,0	0,0	0,0
3	0,0	0,0	0,0	0,9	0,0	0,0	7,0	48,0	0,0	0,0	0,0	0,0
4	0,0	0,0	0,0	8,0	0,0	0,0	0,0	4,0	0,0	0,0	0,0	0,0
5	0,0	0,0	0,0	0,0	1,8	0,0		15,7	0,0	0,0	0,0	0,0
6	0,0	0,0	0,0	4,0	0,0	7,6	0,0	2,0	15,0	0,0	0,0	0,0
7	0,0	0,0	0,0	0,0	1,4	1,1	0,0	10,7	0,0	0,0	0,0	0,0
8	0,0	0,0	0,0	0,0	35,4	0,0	0,0	1,9	0,3	0,0	0,0	0,0
9	0,0	0,0	0,0	0,0	0,7	0,0	0,0	0,0	0,9	0,0	0,0	0,0
10	0,0	0,0	0,0	1,9	2,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0
11	0,0	0,0	0,0	50,2	0,0	0,0	6,0	22,8	0,0	0,0	0,0	0,0
12	0,0	0,0	0,0	18,0	0,0	0,0	12,4	1,1	0,0	0,0	0,0	0,0
13	0,0	0,0	0,0	59,0	0,0	0,0	58,0	17,6	0,0	0,0	0,0	0,0
14	0,0	0,0	0,0	8,0	16,0	0,0	3,0	5,4	0,0	0,0	0,0	0,0
15	0,0	0,0	0,0	10,0	1,0	0,0	7,0	10,5	0,0	0,0	0,0	0,0
16	0,0	2,0	0,0	10,0	17,4	0,0	7,8	0,0	0,0	0,0	0,0	0,0
17	0,0	6,6	4,3	16,0	0,0	0,0	17,0	0,0	0,0	0,0	0,0	0,0
18	0,0	4,0	0,0	4,2	2,4	0,0	35,0	0,0	0,0	0,0	0,0	0,0
19	0,0	0,7	0,0	4,8	0,0	0,0	4,5	0,0	0,0	0,0	0,0	0,0
20	0,0	0,0	18,0	0,8	10,7	0,0	2,9	0,0	0,0	0,0	0,0	0,0
21	0,0	0,0	64,0	5,0	4,8	0,0	5,5	3,5	0,0	0,0	0,0	0,0
22	0,0	0,0	40,0	16,0	0,0	0,0	28,0	8,9	8,7	0,0	0,0	0,0
23	0,0	0,0	15,0	17,0	0,0	0,0	17,6	0,0	0,0	0,0	0,0	0,0
24	0,0	0,0	12,0	45,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
25	0,0	0,0	2,0	1,8	0,7	1,7	8,0	0,0	0,0	0,0	0,0	0,0
26	0,0	0,0	5,0	22,0	0,0	11,0	0,0	0,0	0,0	0,0	0,0	0,0
27	0,0	0,0	0,0	1,3	0,0	7,2	15,6	0,0	0,0	0,0	0,0	0,0
28	0,0	0,0	0,0	2,8	0,0	9,5	12,7	0,0	0,0	0,0	0,0	0,0
29	0,0	0	0,0	0,0	0,0	1,5	0,6	8,5	0,0	0,0	0,0	0,0
30	0,0	0	5,0	0,0	0,0	13,5	29,0	1,5	0,0	0,0	0,0	0,0
31		0	45,5		2,4		0,0	7,5		0,0		0,0

YEAR 1981 RAIN (mm/m^2)											
JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
0,0	0,0	0,0	0,0	0,0	0,7	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	0,0	0,0	4,3	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,9	0,0	0,0	7,0	48,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	8,0	0,0	0,0	0,0	4,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	1,8	0,0		15,7	0,0	0,0	0,0	0,0
0,0	0,0	0,0	4,0	0,0	7,6	0,0	2,0	15,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	1,4	1,1	0,0	10,7	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	35,4	0,0	0,0	1,9	0,3	0,0	0,0	0,0
0,0	0,0	0,0	0,0	0,7	0,0	0,0	0,0	0,9	0,0	0,0	0,0
0,0	0,0	0,0	1,9	2,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	50,2	0,0	0,0	6,0	22,8	0,0	0,0	0,0	0,0
0,0	0,0	0,0	18,0	0,0	0,0	12,4	1,1	0,0	0,0	0,0	0,0
0,0	0,0	0,0	59,0	0,0	0,0	58,0	17,6	0,0	0,0	0,0	0,0
0,0	0,0	0,0	8,0	16,0	0,0	3,0	5,4	0,0	0,0	0,0	0,0
0,0	0,0	0,0	10,0	1,0	0,0	7,0	10,5	0,0	0,0	0,0	0,0
0,0	2,0	0,0	10,0	17,4	0,0	7,8	0,0	0,0	0,0	0,0	0,0
0,0	6,6	4,3	16,0	0,0	0,0	17,0	0,0	0,0	0,0	0,0	0,0
0,0	4,0	0,0	4,2	2,4	0,0	35,0	0,0	0,0	0,0	0,0	0,0
0,0	0,7	0,0	4,8	0,0	0,0	4,5	0,0	0,0	0,0	0,0	0,0
0,0	0,0	18,0	0,8	10,7	0,0	2,9	0,0	0,0	0,0	0,0	0,0
0,0	0,0	64,0	5,0	4,8	0,0	5,5	3,5	0,0	0,0	0,0	0,0
0,0	0,0	40,0	16,0	0,0	0,0	28,0	8,9	8,7	0,0	0,0	0,0
0,0	0,0	15,0	17,0	0,0	0,0	17,6	0,0	0,0	0,0	0,0	0,0
0,0	0,0	12,0	45,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	2,0	1,8	0,7	1,7	8,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	5,0	22,0	0,0	11,0	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	1,3	0,0	7,2	15,6	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	2,8	0,0	9,5	12,7	0,0	0,0	0,0	0,0	0,0
0,0	0	0,0	0,0	0,0	1,5	0,6	8,5	0,0	0,0	0,0	0,0
0,0	0	5,0	0,0	0,0	13,5	29,0	1,5	0,0	0,0	0,0	0,0
	0	45,5		2,4		0,0	7,5		0,0		0,0

YEAR 1982 RAIN (mm/m^2)

DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	49,0	0,0	10,0	0,0	0,0	0,0	0,0	0,0	0,0
2	0,0	5,0	0,0	4,5	0,0	0,0	0,0	6,4	4,3	0,0	2,0	0,0
3	0,0	0,0	0,0	1,0	0,0	0,0	2,1	14,7	7,0	48,0	0,8	0,0
4	0,0	0,0	0,0	1,4	0,2	0,0	10,2	6,4	0,0	4,0	0,3	0,0
5	0,0	0,0	0,0	1,6	6,1	0,0	22,9	19,8		15,7	0,0	0,0
6	0,0	0,0	0,0	0,0	2,4	0,0	0,0	0,0	0,0	2,0	0,0	0,5
7	0,0	0,0	1,5	0,0	32,8	0,0	0,0	0,0	0,0	10,7	0,0	5,6
8	0,0	0,0	0,0	2,0	0,0	0,0	0,0	7,6	0,0	1,9	0,0	0,0
9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	12,7	0,0	0,0	0,0	6,3
10	0,0	0,5	0,0	0,0	0,3	0,0	0,0	0,0	1,0	0,0	0,0	0,0
11	0,0	1,3	0,0	0,0	9,1	0,0	0,0	4,8	6,0	22,8	0,0	2,0
12	0,0	0,0	0,0	1,0	16,0	0,0	0,0	20,3	12,4	1,1	0,0	0,0
13	0,0	0,0	0,0	1,0	36,0	0,0	0,0	22,1	58,0	17,6	1,1	0,0
14	0,0	1,4	0,0	8,5	11,1	0,0	0,0	10,4	3,0	5,4	0,6	0,0
15	0,0	42,1	0,0	3,4	3,2	3,8	0,0	23,6	7,0	10,5	3,0	0,6
16	0,0	41,0	0,0	57,1	14. 3	2,3	71,1	26,9	7,8	0,0	0,0	0,0
17	3,5	0,0	0,0	21,5	5,5	22,8	7,6	52,6	17,0	0,0	0,0	0,0
18	0,0	0,0	0,0	40,5	3,2	3,6	0,0	6,9	35,0	0,0	0,0	0,5
19	0,0	0,0	0,0	20,2	14,2	0,0	28,0	0,0	4,5	0,0	13,5	0,0
20	0,0	0,0	0,0	34,6	1,1	0,3	0,0	0,0	2,9	0,0	17,0	0,0
21	0,0	0,0	0,0	5,0	15,0	4,8	0,0	17,8	5,5	3,5	3,1	3,0
22	0,0	0,0	0,0	10,7	3,0	6,1	0,0	11,2	28,0	8,9	0,7	1,5
23	0,0	0,0	0,0	1,3	0,0	11,5	46,0	25,4	17,6	0,0	0,0	1,5
24	0,0	0,0	0,0	0,0	7,9	0,0	23,0	18,9	0,0	0,0	0,0	4,5
25	0,0	0,0	0,0	14,2	0,2	0,0	0,0	5,1	8,0	0,0	2,7	0,8
26	0,0	0,0	0,0	10,0	0,2	0,0	0,0	25,4	0,0	0,0	12,3	0,0
27	0,0	0,0	0,0	69,4	0,4	0,0	7,6	23,4	15,6	0,0	15,9	0,0
28	0,0	0,0	0,0	1,3	62,8	0,0	0,0	0,0	12,7	0,0	16,5	0,0
29	0,0		21,5	17,8	49,6	1,4	0,0	0,0	0,6	8,5	2,5	0,0
30	0,0		0,7	0,0	49,5	0,0	0,0	0,0	29,0	1,5	0,0	0,0
31	0,0		0,3		27,0		33,0	0,0	0,0	7,5		0,0

YEAR 1983 RAIN (mm/m^2)

DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,5	0,0	0,0
2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0
3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0
4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	1,0	0,0	0,0	0,0
5	0,0	0,0	0,0	7,4	0,1	0,0	0,1	0,0	0,6	0,0	0,0	0,0
6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,0
7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,4	0,0	0,0
8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,8	0,1	0,0	0,0
9	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,0	1,0	0,0	0,0	0,0
10	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,1	0,0	0,0	0,0	0,0
11	0,0	0,0	0,0	0,0	0,0	0,0	0,7	1,3	0,0	0,0	0,0	0,1
12	0,0	1,4	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,0	0,0	0,0
13	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,1	0,0	0,0	0,0	0,0
14	0,0	0,0	0,0	0,0	0,0	0,1	0,3	0,0	0,0	0,0	0,0	0,0
15	0,0	0,2	0,0	1,0	0,0	0,0	0,1	0,0	0,0	0,1	0,0	0,0
16	0,0	0,0	0,0	4,6	0,0	1,5	0,4	0,1	0,1	0,0	0,0	0,0
17	0,0	0,0	0,0	0,0	0,0	0,6	1,1	1,2	0,0	0,0	0,0	0,0
18	0,0	0,0	0,0	8,4	0,0	0,2	0,0	1,4	0,8	1,5	0,0	0,0
19	0,0	0,9	0,0	0,5	0,1	0,8	0,6	0,6	0,0	0,1	0,0	0,0
20	0,0	1,0	0,0	0,0	0,1	0,2	0,0	0,0	0,0	0,3	0,0	0,0
21	0,0	0,3	0,0	0,0	0,6	0,4	0,0	0,8	1,8	0,0	0,0	0,0
22	0,0	0,0	0,0	40,0	0,1	0,5	0,0	0,2	0,5	0,0	0,0	0,0
23	0,0	0,0	0,0	3,3	0,1	0,6	0,4	0,0	0,2	0,0	0,0	0,0
24	0,0	0,0	0,0	29,5	0,1	0,1	0,7	0,0	0,2	0,0	0,5	0,0
25	0,0	0,0	0,0	0,0	0,1	0,0	0,5	0,0	0,1	0,0	0,7	0,0
26	0,0	0,0	0,0	3,3	0,0	0,8	0,3	0,0	0,0	0,0	0,8	0,0
27	7,9	0,0	0,0	50,8	0,7	0,4	0,0	0,0	0,1	0,0	1,2	0,0
28	0,3	0,0	0,0	3,6	0,3	0,0	0,2	0,0	0,0	0,0	4,7	0,0
29	9,4		0,0	0,4	0,6	0,0	2,2	0,0	0,2	0,0	0,0	0,0
30	0,3		0,0	0,8	0,3	0,1	0,4	0,0	0,0	0,0	0,0	0,0
31	0,0		0,0	1,0		0,2	0,4		0,1		0,0	0,0

YEAR 1984 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,5	0,0	0,0	0,0	0,0	13,6	15,9	0,0
2	0,0	0,0	0,0	0,0	19,0	0,0	0,0	0,0	0,0	33,6	12,8	0,0
3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4	0,0
4	0,0	0,0	1,5	0,0	1,5	0,0	0,0	0,0	4,3	20,0	0,0	0,0
5	0,0	0,0	11,0	0,0	1,1	0,0	0,0	0,0	7,1	9,9	26,4	0,0
6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,8	8,4	0,0	0,0
7	0,0	0,0	12,6	3,8	1,5	3,1	0,0	0,0	1,3	0,4	0,0	0,0
8	0,0	0,0	0,0	1,0	6,6	16,0	3,6	3,6	14,0	0,0	0,0	0,0
9	0,0	0,0	0,0	3,5	5,9	10,0	0,0	0,0	4,6	0,0	0,0	4,0
10	0,0	0,0	0,0	15,4	0,0	1,5	16,0	16,0	0,8	0,0	0,0	13,5
11	0,0	0,0	0,0	0,0	0,0	10,5	0,0	0,0	0,0	0,0	2,3	11,4
12	0,0	0,0	0,0	3,5	0,0	0,0	43,2	43,2	0,0	0,0	0,0	0,5
13	0,0	0,0	0,0	0,0	0,0	0,0	4,2	4,2	1,3	0,0	0,0	0,0
14	0,0	0,0	0,0	0,0	0,4	6,4	2,6	2,6	4,3	3,7	2,6	0,0
15	0,0	0,0	0,0	1,2	1,4	0,0	29,1	29,1	0,0	25,8	0,0	0,0
16	0,0	0,0	0,0	2,8	0,6	25,5	11,3	11,3	0,0	0,0	3,9	0,0
17	0,0	0,0	0,0	1,9	0,0	4,8	0,0	0,0	0,0	1,9	0,0	0,0
18	0,0	0,0	0,5	0,0	0,5	1,9	110,0	110,0	0,0	0,0	0,0	0,0
19	0,0	0,0	0,0	0,0	11,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
20	0,0	0,0	0,0	8,3	0,7	0,0	0,0	0,0	0,0	0,0	2,4	0,0
21	0,0	0,0	3,0	13,1	1,9	0,0	0,0	0,0	0,0	0,0	9,0	0,0
22	0,0	0,0	0,0	19,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
23	0,0	0,0	0,0	9,4	14,5	0,0	0,0	0,0	0,0	0,0	2,2	0,0
24	0,0	0,0	0,0	29,3	0,0	8,5	0,0	0,0	2,3	0,0	0,0	0,0
25	0,0	0,0	0,0	68,8	0,0	21,6	0,0	0,0	0,5	0,0	0,0	0,0
26	0,0	0,0	0,0	32,2	1,3	0,0	0,0	0,0	0,0	0,7	0,0	0,0
27	0,0	0,0	0,0	7,0	0,0	13,3	0,0	0,0	0,0	2,3	0,0	0,0
28	0,0	0,0	0,0	0,5	0,0	4,0	0,0	0,0	0,0	6,7	0,0	0,0
29	0,0		0,0	12,2	1,2	1,4	0,0	0,0	0,0	0,0	0,0	0,0
30	0,0		0,0	8,0	0,1	0,5	0,0	0,0	0,0	0,0	0,0	0,0
31	0,0		0,0		0,0		0,0	0,0		0,0		0,0

YEAR 1985 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	21,1	21,1	0,3	0,0	2,5	0,0	0,0	1,4	1,4
2	0,0	1,8	0,0	0,0	0,0	0,0	0,0	26,8	0,0	0,0	1,2	1,2
3	0,0	0,0	0,0	0,0	2,0	0,1	0,0	5,6	0,0	0,0	0,0	0,0
4	0,0	0,0	0,0	0,0	11,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0
5	0,0	0,5	0,0	0,0	4,4	0,0	0,0	0,7	0,0	0,0	0,0	0,0
6	0,0	12,7	0,0	0,0	24,4	0,0	1,6	0,0	0,0	3,6	0,8	0,8
7	0,0	2,5	0,0	1,3	21,4	0,0	0,0	0,0	0,0	19,2	0,0	0,0
8	0,0	0,0	0,0	5,1	4,6	0,0	0,1	0,0	0,0	0,0	0,0	0,0
9	0,0	0,0	0,0	0,0	9,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
10	0,0	0,0	0,0	81,5	13,0	0,1	0,0	10,5	0,0	20,7	0,0	0,0
11	0,0	0,0	0,0	19,1	0,0	0,2	0,0	0,9	2,5	4,2	0,0	0,0
12	0,0	0,0	0,0	82,6	2,1	7,3	2,2	0,0	0,0	16,7	0,0	0,0
13	0,0	0,0	0,0	56,6	4,6	0,1	18,9	0,0	0,0	5,0	0,0	0,0
14	0,0	0,0	0,0	27,9	2,3	0,0	14,6	0,0	0,0	0,3	0,0	0,0
15	0,0	0,0	0,0	67,3	4,2	5,2	0,1	0,0	0,0	0,0	0,0	0,0
16	0,0	0,0	0,0	1,8	13,6	0,0	0,0	10,9	0,0	0,0	0,0	0,0
17	0,0	0,0	0,0	9,7	0,8	17,9	0,0	0,0	0,0	0,0	0,0	0,0
18	0,0	0,0	0,0	0,0	9,6	23,2	2,4	0,6	0,0	0,0	0,0	0,0
19	0,0	0,0	0,1	4,1	3,0	26,9	0,0	0,0	0,0	0,0	0,0	0,0
20	0,0	0,0	0,1	0,0	3,5	1,5	23,4	13,9	0,0	0,0	0,0	0,0
21	0,0	0,0	0,2	1,8	25,2	0,0	0,0	0,9	1,8	0,0	0,8	0,8
22	0,0	0,0	0,0	0,0	3,4	0,0	20,0	0,9	0,0	0,0	0,0	0,0
23	0,0	0,0	0,0	11,7	1,3	0,0	0,0	0,0	0,0	2,5	0,0	0,0
24	0,0	0,0	0,3	21,1	4,4	0,0	13,1	0,0	0,0	0,0	0,0	0,0
25	0,0	0,0	0,0	14,0	8,2	0,0	7,6	0,0	0,0	0,0	0,0	0,0
26	0,0	0,0	0,3	0,0	1,7	0,0	6,2	0,7	0,0	0,0	0,0	0,0
27	7,9	0,0	0,3	32,3	0,0	0,0	9,2	8,6	0,0	0,0	3,9	3,9
28	0,3	1,8	1,5	1,8	1,0	0,0	6,5	0,0	0,0	0,0	0,0	0,0
29	9,4		2,3	0,8	0,0	0,0	16,4	3,5	0,0	0,0	0,0	0,0
30	0,3		0,6	5,6	0,0	4,2	0,0	0,0	0,0	0,0	0,0	0,0
31	0,0		0,1		0,0		0,0	2,9	0,0		0,0	0,0

YEAR 1986 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	1,2
2	0,0	0,0	0,0	0,0	19,0	0,0	0,0	0,0	0,0	0,0	0,0	4,5
3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
4	0,0	0,0	1,5	0,0	1,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
5	0,0	0,0	11,0	0,0	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
7	0,0	0,0	12,6	3,8	1,5	3,1	0,0	0,0	0,0	0,0	0,0	4,5
8	0,0	0,0	0,0	1,0	6,6	16,0	3,6	3,6	0,0	0,0	0,0	17,8
9	0,0	0,0	0,0	3,5	5,9	10,0	0,0	0,0	0,0	0,0	0,0	8,9
10	0,0	0,0	0,0	15,4	0,0	1,5	16,0	16,0	0,0	0,0	0,0	1,0
11	0,0	0,0	0,0	0,0	0,0	10,5	0,0	0,0	0,0	0,0	0,0	2,0
12	0,0	0,0	0,0	3,5	0,0	0,0	43,2	43,2	11,2	0,0	0,0	3,0
13	0,0	0,0	0,0	0,0	0,0	0,0	4,2	4,2	2,0	0,2	0,0	0,9
14	0,0	0,0	0,0	0,0	0,4	6,4	2,6	2,6	17,0	0,0	0,0	0,0
15	0,0	0,0	0,0	1,2	1,4	0,0	29,1	29,1	22,9	0,0	0,0	3,0
16	0,0	0,0	0,0	2,8	0,6	25,5	11,3	11,3	17,4	0,0	0,0	0,0
17	0,0	0,0	0,0	1,9	0,0	4,8	0,0	0,0	29,4	0,0	0,0	0,0
18	0,0	0,0	0,5	0,0	0,5	1,9	110,0	110,0	8,9	0,0	0,0	0,0
19	0,0	0,0	0,0	0,0	11,0	0,0	0,0	0,0	2,2	0,9	0,0	0,0
20	0,0	0,0	0,0	8,3	0,7	0,0	0,0	0,0	0,0	0,0	1,1	0,0
21	0,0	0,0	3,0	13,1	1,9	0,0	0,0	0,0	0,0	0,0	0,0	1,3
22	0,0	0,0	0,0	19,8	0,0	0,0	0,0	0,0	0,0	0,0	1,2	1,2
23	0,0	0,0	0,0	9,4	14,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
24	0,0	0,0	0,0	29,3	0,0	8,5	0,0	0,0	0,0	1,2	0,0	0,0
25	0,0	0,0	0,0	68,8	0,0	21,6	0,0	0,0	0,0	0,0	0,0	0,0
26	0,0	0,0	0,0	32,2	1,3	0,0	0,0	0,0	0,0	0,0	0,2	0,0
27	0,0	0,0	0,0	7,0	0,0	13,3	0,0	0,0	0,0	28,1	8,2	0,0
28	0,0	0,0	0,0	0,5	0,0	4,0	0,0	0,0	0,0	0,0	0,0	0,0
29	0,0		0,0	12,2	1,2	1,4	0,0	0,0	0,0	0,0	0,0	0,0
30	0,0		0,0	8,0	0,1	0,5	0,0	0,0	0,0	0,0	8,4	0,0
31	0,0		0,0		0,2		0,2	0,4		0,0		0,0

YEAR 1987 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	3,3	53,1	0,0	0,0	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,0	0,0	57,1	22,4	0,0	0,0	0,0	0,0	0,0
3	0,0	0,0	0,0	0,0	0,0	1,3	20,0	0,0	0,0	0,0	0,0	0,0
4	0,0	0,0	0,0	0,0	0,0	3,2	14,2	0,0	0,0	0,0	0,0	0,0
5	0,0	0,0	0,0	0,0	0,2	10,8	14,5	0,0	0,0	0,0	1,8	2,7
6	0,0	0,0	0,0	30,8	0,0	35,5	0,0	0,0	0,0	0,0	0,8	0,0
7	0,0	0,0	0,0	63,5	0,0	12,8	0,0	0,0	0,0	0,0	6,4	0,0
8	0,0	0,0	0,0	40,5	24,5	37,6	0,0	0,0	0,0	0,0	17,8	0,0
9	0,0	0,0	0,8	30,2	12,6	16,0	0,0	0,0	0,0	0,0	0,4	0,0
10	0,0	0,0	2,6	10,7	5,3	32,2	0,0	0,0	0,0	0,0	0,0	0,0
11	0,0	0,0	19,7	6,5	2,8	8,4	0,0	8,6	0,0	15,1	0,0	0,0
12	0,0	0,0	2,5	7,0	0,0	35,8	0,0	0,0	0,0	20,0	34,8	0,0
13	0,0	28,0	0,0	0,0	76,2	0,7	0,0	0,7	0,0	0,0	7,2	0,0
14	0,0	0,0	0,0	3,1	19,8	0,0	0,0	22,3	0,0	0,0	55,0	0,0
15	0,0	0,0	0,7	0,0	4,6	0,0	0,0	10,7	0,0	0,0	31,8	0,0
16	0,0	0,0	23,4	0,0	0,4	0,0	0,0	0,0	0,0	0,0	2,4	0,0
17	0,0	0,0	0,0	0,0	22,3	0,0	0,0	0,0	0,0	0,8	8,8	0,0
18	0,0	0,0	0,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
19	0,0	0,0	5,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
20	0,0	26,2	2,0	0,0	0,0	0,0	0,0	2,8	0,0	1,5	0,0	0,0
21	0,0	15,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,0
22	0,0	0,0	0,0	0,0	0,0	0,0	0,0	8,7	0,0	0,0	0,0	0,0
23	0,0	0,0	0,0	0,0	100,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
24	0,0	0,0	0,0	0,2	39,9	0,0	0,0	7,5	0,0	1,8	3,0	0,0
25	0,0	0,0	0,0	0,0	77,9	0,0	0,0	0,0	1,5	0,0	0,0	0,0
26	0,0	0,0	0,0	0,0	4,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0
27	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0
28	0,0	0,0	0,0	0,0	0,0	3,8	0,0	0,5	1,5	0,0	0,0	0,0
29	0,0		0,0	0,0	2,4	0,0	0,0	3,5	1,6	0,0	0,0	0,0
30	0,0		0,1	0,0	22,0	19,4	0,0	0,0	0,0	0,0	0,0	0,0
31	0,0		0,0		0,0		0,0	0,0		0,0		0,0

YEAR 1988 RAIN (mm/m^2)

DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	1,6	1,6	8,4	0,0	0,0	13,6	15,9	0,0
2	0,0	2,2	0,0	0,0	2,1	2,1	0,0	0,0	0,0	33,6	12,8	0,0
3	0,0	0,0	0,0	0,0	19,2	19,2	0,0	0,0	0,0	0,0	1,4	0,0
4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	27,2	24,7	20,0	0,0	0,0
5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,0	12,4	9,9	26,4	0,0
6	0,0	0,0	0,0	0,0	24,3	24,3	4,9	8,7	7,0	8,4	0,0	0,0
7	0,0	0,0	0,0	28,9	0,0	0,0	2,1	9,9	0,0	0,4	0,0	0,0
8	0,0	0,0	0,0	0,0	31,8	31,8	0,0	4,2	0,0	0,0	0,0	0,0
9	0,0	0,0	0,0	0,0	3,3	3,3	0,0	18,4	0,0	0,0	0,0	2,3
10	0,0	0,0	0,0	8,0	0,0	0,0	0,0	29,1	0,0	0,0	0,0	0,0
11	0,0	5,5	0,0	5,6	0,0	0,0	17,6	8,0	0,0	0,0	2,3	0,0
12	0,0	1,3	0,0	7,1	0,0	0,0	19,4	3,1	0,0	0,0	0,0	0,0
13	0,0	0,0	0,0	8,4	0,0	0,0	7,2	0,0	0,0	0,0	0,0	0,0
14	0,0	0,0	0,0	0,4	0,0	0,0	41,7	0,0	2,3	3,7	2,6	0,0
15	0,0	0,0	0,0	4,7	13,9	13,9	51,1	0,0	0,0	25,8	0,0	0,0
16	6,5	0,0	0,0	0,0	36,7	36,7	1,4	1,1	0,0	0,0	3,9	0,0
17	3,5	0,0	0,0	5,0	13,2	13,2	41,8	15,5	0,0	1,9	0,0	0,0
18	80,0	0,0	0,0	24,6	3,8	3,8	20,1	17,2	20,7	0,0	0,0	0,0
19	10,9	0,0	10,0	53,0	0,0	0,0	15,3	35,0	8,6	0,0	0,0	17,1
20	1,6	0,0	10,0	2,2	0,0	0,0	0,0	14,8	0,0	0,0	2,4	0,0
21	0,0	0,0	0,0	0,0	0,0	0,0	0,0	9,2	5,0	0,0	9,0	6,4
22	0,2	0,0	0,0	54,5	3,4	3,4	2,5	0,0	23,9	0,0	0,0	0,0
23	0,0	0,0	0,0	23,6	0,0	0,0	0,0	4,8	33,9	0,0	2,2	2,7
24	0,0	0,0	0,0	3,0	0,0	0,0	6,5	0,0	36,9	0,0	0,0	0,0
25	0,0	0,0	0,0	30,3	0,0	0,0	11,9	1,0	24,6	0,0	0,0	0,0
26	0,0	1,6	0,0	27,1	0,0	0,0	0,9	0,0	3,6	0,7	0,0	2,8
27	0,0	0,0	9,0	5,2	0,0	0,0	4,2	0,0	0,0	2,3	0,0	0,0
28	0,0	0,0	0,0	1,5	0,0	0,0	4,2	1,2	0,0	6,7	0,0	2,3
29	0,0	0,0	0,0	32,1	0,0	0,0	0,0	5,8	13,6	0,0	0,0	1,0
30	0,0		0,0	4,5	0,0	0,0	19,4	0,0	21,2	0,0	0,0	2,8
31	2,3		0,0		0,0	0,0	8,7	0,0		0,0		0,0

YEAR 1989 RAIN (mm/m^2)

DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	10,0		0,0	18,4	0,0	0,0	4,8
2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,9	0,0	0,0	1,6
3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,2	0,0	0,0	6,5
4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
5	0,0	5,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
7	0,0	0,0	0,0	64,5	0,0	0,0	0,0	0,0	2,0	48,0	0,0	1,1
8	9,3	48,1	0,0	0,0	14,2	0,0	0,0	0,0	2,1	41,7	0,0	0,0
9	0,0	25,7	0,0	19,7	65,3	0,0	14,2	0,0	0,0	0,0	0,0	0,0
10	0,0	14,2	0,0	27,0	10,0	0,0	65,3	3,7	0,0	0,0	0,0	0,0
11	0,0	0,0	0,0	4,1	4,0	0,0	10,0	7,4	0,0	4,0	2,9	0,0
12	0,0	0,0	0,0	1,3	4,3	0,0	4,0	0,0	0,0	5,3	0,0	0,0
13	0,0	0,0	2,8	0,0	4,7	0,0	4,3	0,0	0,0	0,0	2,0	0,0
14	0,0	0,0	1,4	0,0	0,0	0,0	4,7	1,9	0,0	0,0	2,1	0,0
15	0,0	0,0	0,0	0,0	0,0	3,8	0,0	0,0	0,0	0,0	0,0	0,0
16	4,5	0,0	0,0	0,0	0,0	2,3	0,0	0,0	0,0	0,0	0,0	0,0
17	0,0	0,0	0,0	0,0	0,0	22,8	0,0	0,0	0,0	0,0	4,7	0,0
18	0,0	0,0	0,0	0,0	0,0	3,6	0,0	0,0	0,0	0,0	16,7	0,0
19	1,5	0,0	4,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
20	0,0	0,0	32,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0
21	0,0	0,0	13,6	0,0	0,0	4,8	0,0	6,9	0,0	0,0	0,0	0,0
22	0,0	1,5	1,8	0,0	0,0	6,1	0,0	4,3	0,0	0,0	5,2	0,0
23	0,0	0,0	0,0	0,0	0,0	11,5	0,0	0,0	0,0	0,0	1,5	0,0
24	8,3	0,0	0,0	73,0	0,0	0,0	0,0	0,0	28,4	0,0	0,0	5,2
25	0,0	0,0	6,0	8,7	0,0	0,0	0,0	0,0	25,6	6,7	0,0	5,6
26	0,0	0,0	4,3	14,3	0,0	0,0	0,0	0,0	0,0	0,0	2,8	2,3
27	0,0	0,0	0,0	3,6	0,0	0,0	0,0	9,3	0,0	0,0	17,7	0,0
28	0,0	0,0	1,3	34,0	0,0	0,0	0,0	12,4	17,8	10,0	0,8	0,0
29	0,0		6,3	33,0	0,0	1,4	0,0	58,3	0,0	0,0	0,0	3,4
30	0,0		4,4	4,0	0,0	0,0	0,0	0,0	0,0	0,0	9,8	0,0
31	0,0		8,9		0,0		0,0	0,0		0,0		0,0

YEAR 1990 RAIN (mm/m^2)

DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	42,0	0,0	0,0	12,1	0,0	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,0	61,6	0,0	1,2	0,0	0,0	3,6	0,0	0,0
3	0,0	0,0	0,0	130,5	0,0	0,0	25,3	24,3	0,0	0,0	0,0	0,0
4	0,0	0,0	0,0	0,0	0,0	0,0	9,0	50,6	0,0	0,0	4,3	0,0
5	0,0	0,0	0,0	10,2	5,4	0,0	0,0	50,5	0,0	0,0	7,1	0,0
6	0,0	0,0	0,0	20,1	3,2	0,0	0,0	21,2	4,1	0,0	18,5	0,0
7	0,0	0,0	0,0	10,0	0,0	0,0	58,0	22,3	0,0	0,0	14,6	0,0
8	4,6	4,6	0,0	0,0	0,0	0,0	9,6	31,2	0,0	0,0	0,0	0,0
9	0,0	0,0	0,0	4,0	0,0	0,0	4,6	9,0	0,0	0,0	0,0	0,0
10	8,2	0,0	0,0	4,8	0,0	0,0	0,0	0,0	0,0	8,8	0,0	4,3
11	0,0	0,0	0,0	4,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	13,5
12	0,0	0,0	0,0	0,0	1,2	0,0	0,0	0,0	0,0	5,2	0,0	7,6
13	5,6	0,0	0,0	10,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	9,3
14	0,0	0,0	0,0	63,3	0,0	0,0	0,0	0,0	0,0	4,3	0,0	15,5
15	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
16	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
17	0,0	0,0	0,0	0,0	0,0	8,6	6,8	0,0	0,0	0,0	0,0	0,0
18	0,0	0,0	0,0	0,0	0,0	12,0	0,0	0,0	0,0	6,0	0,0	0,0
19	0,0	0,0	2,6	0,0	0,0	30,1	0,0	1,8	0,0	12,0	0,0	0,0
20	0,0	0,0	0,0	0,0	0,0	4,8	0,0	0,0	0,0	10,0	0,0	0,0
21	0,0	23,5	0,0	0,0	0,0	3,6	1,9	0,0	0,0	6,0	0,0	0,0
22	2,6	2,6	0,0	0,0	0,0	0,0	0,3	9,4	0,0	18,0	0,0	0,0
23	6,0	6,0	0,0	0,0	0,0	0,0	90,1	1,3	0,0	2,0	0,0	0,0
24	8,3	8,3	0,4	7,8	0,0	0,0	0,0	25,6	0,0	0,0	0,0	0,0
25	2,5	2,5	0,0	24,0	0,0	0,0	15,0	0,0	0,0	0,0	0,0	0,0
26	0,0	0,0	0,0	11,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
27	0,0	0,0	0,0	0,0	0,0	0,0	39,0	0,0	0,0	0,0	0,0	0,0
28	0,0		0,0	0,0	0,0	0,0	15,8	0,0	0,0	10,7	0,0	0,0
29	0,0		10,0	0,0	0,0	0,0	0,0	0,0	0,0	3,0	0,0	0,0
30	0,0		12,0	0,0	0,0	27,4	0,0	0,0	0,0	12,9		0,0
31	0,0		16,0		0,0		0,0	0,0		0,0		0,0

YEAR 1991 RAIN (mm/m^2)

DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	0,0	38,3	0,0	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,0	0,0	0,5	10,0	14,2	12,3	0,0	0,0	0,0
3	0,0	0,0	0,0	0,0	0,0	17,7	30,0	0,0	0,0	0,0	0,0	0,0
4	0,0	0,0	0,0	0,0	0,0	1,5	0,0	6,5	0,0	0,0	0,0	0,0
5	0,0	0,0	0,0	26,3	0,0	16,0	0,0	11,0	0,0	0,0	3,3	0,0
6	0,0	0,0	0,0	0,0	2,0	32,0	7,2	0,0	0,0	0,0	0,0	0,0
7	0,0	0,0	0,0	0,0	0,0	19,1	2,2	0,0	0,0	0,0	1,2	2,3
8	8,5	0,0	0,0	0,0	0,0	3,0	1,0	0,0	0,0	0,0	7,1	0,0
9	18,8	0,0	0,0	0,0	12,0	25,6	0,0	7,1	1,3	0,0	2,8	1,2
10	0,0	0,0	0,0	0,0	0,0	3,7	7,7	0,0	2,8	0,0	0,0	1,2
11	0,0	0,0	0,0	1,5	0,0	0,1	0,0	0,0	0,0	0,0	0,0	18,8
12	0,0	0,0	0,0	2,0	2,7	0,0	6,7	0,0	0,0	0,0	0,0	1,2
13	0,0	0,0	0,0	3,5	0,0	43,2	2,5	21,1	3,0	0,0	0,0	1,3
14	0,0	0,0	0,0	3,0	6,1	0,0	0,0	2,9	2,4	3,2	0,0	0,0
15	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	14,7	0,0	0,0
16	0,0	0,0	0,0	0,0	7,2	5,0	0,0	0,0	0,0	0,0	0,0	0,0
17	0,0	0,0	0,0	0,0	0,0	0,0	3,1	3,2	0,0	0,0	0,0	0,0
18	0,0	0,0	0,0	0,0	10,0	0,0	31,1	0,0	0,0	0,0	1,2	0,0
19	0,0	0,0	0,0	0,0	0,0	0,0	5,1	7,5	0,0	0,0	0,0	0,0
20	0,0	0,0	14,7	0,0	0,0	0,0	2,7	1,0	0,0	3,2	1,3	0,8
21	0,0	0,0	0,0	0,0	0,0	0,0	13,3	11,4	0,0	2,1	26,3	2,1
22	0,0	0,0	0,0	0,0	15,6	0,0	0,0	12,1	0,0	9,3	0,0	0,5
23	0,0	0,0	0,0	0,0	0,0	0,0	1,7	21,7	0,0	0,0	21,0	0,0
24	0,0	0,0	0,0	0,0	14,2	0,0	0,0	9,4	0,0	0,0	2,3	27,1
25	0,0	0,0	0,0	9,1	22,0	6,7	0,0	17,1	21,6	0,0	0,0	0,0
26	0,0	0,0	19,3	0,0	25,1	0,0	0,0	0,0	6,1	5,6	0,0	0,0
27	16,0	0,0	59,4	0,0	0,6	5,9	0,0	0,0	0,0	16,9	0,0	0,0
28	6,5	0,0	1,0	0,0	0,0	0,0	9,4	20,0	0,0	0,0	0,0	0,0
29	0,0		0,0	0,0	2,0	1,1	16,0	21,3	0,0	0,0	0,0	0,0
30	0,0		0,0	17,6	16,8	31,7	12,7	3,0	0,0	0,0	0,0	0,0
31	0,0		0,0		5,2		0,0	0,0		0,0		0,0

YEAR 1992 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	10,0		0,0	18,4	0,0	0,0	4,8
2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,9	0,0	0,0	1,6
3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,2	0,0	0,0	6,5
4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
5	0,0	5,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
7	0,0	0,0	0,0	64,5	0,0	0,0	0,0	0,0	2,0	48,0	0,0	1,1
8	0,0	48,1	0,0	0,0	14,2	0,0	0,0	0,0	2,1	41,7	0,0	0,0
9	0,0	25,7	0,0	19,7	65,3	0,0	14,2	0,0	0,0	0,0	0,0	0,0
10	0,0	14,2	0,0	27,0	10,0	0,0	65,3	3,7	0,0	0,0	0,0	0,0
11	0,0	0,0	0,0	4,1	4,0	0,0	10,0	7,4	0,0	4,0	2,9	0,0
12	0,0	0,0	0,0	1,3	4,3	0,0	4,0	0,0	0,0	5,3	0,0	0,0
13	1,8	0,0	2,8	0,0	4,7	0,0	4,3	0,0	0,0	0,0	2,0	0,0
14	0,0	0,0	1,4	0,0	0,0	0,0	4,7	1,9	0,0	0,0	2,1	0,0
15	0,0	0,0	0,0	0,0	0,0	3,8	0,0	0,0	0,0	0,0	0,0	0,0
16	0,0	0,0	0,0	0,0	0,0	2,3	0,0	0,0	0,0	0,0	0,0	0,0
17	0,0	0,0	0,0	0,0	0,0	22,8	0,0	0,0	0,0	0,0	4,7	0,0
18	0,0	0,0	0,0	0,0	0,0	3,6	0,0	0,0	0,0	0,0	16,7	0,0
19	0,0	0,0	4,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
20	0,0	0,0	32,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0
21	0,0	0,0	13,6	0,0	0,0	4,8	0,0	6,9	0,0	0,0	0,0	0,0
22	0,0	1,5	1,8	0,0	0,0	6,1	0,0	4,3	0,0	0,0	5,2	0,0
23	0,0	0,0	0,0	0,0	0,0	11,5	0,0	0,0	0,0	0,0	1,5	0,0
24	0,0	0,0	0,0	73,0	0,0	0,0	0,0	0,0	28,4	0,0	0,0	5,2
25	0,0	0,0	6,0	8,7	0,0	0,0	0,0	0,0	25,6	6,7	0,0	5,6
26	0,0	0,0	4,3	14,3	0,0	0,0	0,0	0,0	0,0	0,0	2,8	2,3
27	0,0	0,0	0,0	3,6	0,0	0,0	0,0	9,3	0,0	0,0	17,7	0,0
28	0,0	0,0	1,3	34,0	0,0	0,0	0,0	12,4	17,8	10,0	0,8	0,0
29	0,0		6,3	33,0	0,0	1,4	0,0	58,3	0,0	0,0	0,0	3,4
30	0,0		4,4	4,0	0,0	0,0	0,0	0,0	0,0	0,0	9,8	0,0
31	0,0		8,9		0,0		0,0	0,0		0,0		0,0

YEAR 1993 RAIN (mm/m^2)											
JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
0,0	0,0	13,8	0,0	0,0	0,0	0,0	0,0	0,0	1,4	0,0	0,0
0,0	0,0	0,0	0,0	5,8	0,0	0,0	0,0	0,0	55,4	0,0	0,0
0,0	0,0	8,8	0,0	10,0	0,0	0,0	0,0	0,0	27,2	0,0	0,0
0,0	0,0	0,0	0,0	7,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	5,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	56,6	1,4	0,0	0,0	0,0	0,0	1,5	0,0	0,0
0,0	0,0	0,0	14,8	4,0	7,8	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	2,7	0,0	0,0	16,2	0,0	0,0	0,0	0,0
0,0	0,0	0,0	2,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	0,0	1,5	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	1,1	0,0	0,0	0,0	0,0	6,3	2,3	0,0	0,0
0,0	0,0	0,0	0,0	0,0	0,0	0,0	17,4	0,0	0,0	3,9	0,0
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	6,6	0,0	46,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	0,0	0,0	2,3	0,0	11,2	0,0	0,0	0,0
0,0	0,0	0,0	0,0	2,6	0,0	40,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	11,8	0,0	0,0	0,0
0,0	0,0	4,7	0,0	2,0	0,0	28,4	0,0	5,8	1,7	0,0	0,0
0,0	0,0	0,5	0,0	0,0	0,0	2,4	0,0	0,0	1,8	0,0	0,0
0,0	0,0	12,2	0,0	0,0	0,0	0,0	0,0	0,0	18,0	0,0	0,0
0,0	0,0	1,5	0,0	0,0	0,0	42,4	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	0,0	40,6	2,5	0,0	0,0	0,0	0,0	0,0
0,0	0,0	71,5	3,0	0,0	1,0	3,6	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	0,0	0,0	52,0	0,0	13,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
32,0	0,0	0,0	0,0	0,0	2,2	3,0	0,0	0,0	0,0	0,0	0,0
25,0	0,0	0,0	0,0	0,0	3,2	32,5	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	12,0	0,0	3,0	32,5	0,0	0,0	0,0	0,0	0,0
6,1		0,0	6,3	0,0	0,0	14,0	0,0	0,0	0,0	0,0	0,0
29,1		0,0	2,8	14,6	0,0	0,0	46,8	7,0	0,0	0,0	0,0
3,5		0,0		0,0			0,0		0,0		0,0

YEAR 1994 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	10,0		0,0	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
5	0,0	5,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
7	0,0	0,0	0,0	64,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
8	0,0	48,1	0,0	0,0	14,2	0,0	0,0	0,0	4,0	0,0	0,0	0,0
9	0,0	25,7	0,0	19,7	65,3	0,0	14,2	0,0	0,0	0,0	0,0	73,0
10	0,0	14,2	0,0	27,0	10,0	0,0	65,3	3,7	0,0	0,0	0,0	12,0
11	0,0	0,0	0,0	4,1	4,0	0,0	10,0	7,4	0,0	0,0	0,0	0,0
12	0,0	0,0	0,0	1,3	4,3	0,0	4,0	0,0	0,0	0,0	0,0	0,0
13	1,8	0,0	2,8	0,0	4,7	0,0	4,3	0,0	0,0	4,4	0,0	0,0
14	0,0	0,0	1,4	0,0	0,0	0,0	4,7	1,9	0,0	0,0	6,7	0,0
15	0,0	0,0	0,0	0,0	0,0	3,8	0,0	0,0	0,0	0,0	0,0	0,0
16	0,0	0,0	0,0	0,0	0,0	2,3	0,0	0,0	0,0	0,0	0,0	0,0
17	0,0	0,0	0,0	0,0	0,0	22,8	0,0	0,0	0,0	0,0	7,8	0,0
18	0,0	0,0	0,0	0,0	0,0	3,6	0,0	0,0	0,0	7,8	0,0	0,0
19	0,0	0,0	4,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4	0,0	0,0
20	0,0	0,0	32,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0
21	0,0	0,0	13,6	0,0	0,0	4,8	0,0	6,9	0,0	0,0	1,4	0,0
22	0,0	1,5	1,8	0,0	0,0	6,1	0,0	4,3	0,0	2,0	0,0	0,0
23	0,0	0,0	0,0	0,0	0,0	11,5	0,0	0,0	0,0	0,0	0,0	0,0
24	0,0	0,0	0,0	73,0	0,0	0,0	0,0	0,0	0,0	1,1	0,0	0,0
25	0,0	0,0	6,0	8,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
26	0,0	0,0	4,3	14,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
27	0,0	0,0	0,0	3,6	0,0	0,0	0,0	9,3	0,0	0,0	6,0	0,0
28	0,0	0,0	1,3	34,0	0,0	0,0	0,0	12,4	0,0	0,0	0,0	0,0
29	0,0		6,3	33,0	0,0	1,4	0,0	58,3	0,0	0,0	0,0	0,0
30	0,0		4,4	4,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
31	0,0		8,9		0,0		0,0	0,0		13,8		0,0

YEAR 1995 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	44,6	5,7	0,0	0,0	0,0	18,4	0,0	0,0	4,8
2	0,0	0,0	0,0	3,3	6,3	5,8	0,0	0,0	4,9	0,0	0,0	1,6
3	0,0	14,3	0,0	0,0	0,0	10,0	0,0	0,0	5,2	0,0	0,0	6,5
4	0,0	0,0	0,0	7,5	0,0	7,6	0,0	0,0	0,0	0,0	0,0	0,0
5	0,0	0,0	0,0	27,2	0,0	0,0	0,0	5,9	0,0	0,0	0,0	0,0
6	0,0	0,0	0,0	6,2	3,0	1,4	0,0	0,0	0,0	0,0	0,0	0,0
7	0,0	0,0	0,0	2,7	0,0	4,0	7,8	0,0	2,0	48,0	0,0	1,1
8	1,4	0,0	0,0	0,0	0,0	2,7	0,0	0,0	2,1	41,7	0,0	0,0
9	0,0	1,4	0,0	0,0	0,0	0,0	0,0	0,8	0,0	0,0	0,0	0,0
10	0,0	0,0	0,0	40,1	3,3	0,0	1,5	0,0	0,0	0,0	0,0	0,0
11	0,0	0,0	0,0	53,8	0,0	0,0	0,0	0,0	0,0	4,0	2,9	0,0
12	0,0	0,0	37,4	5,6	0,0	0,0	0,0	29,4	0,0	5,3	0,0	0,0
13	0,0	0,0	12,7	1,9	0,0	0,0	0,0	0,0	0,0	0,0	2,0	0,0
14	22,0	0,0	0,0	2,0	0,0	6,6	0,0	0,0	0,0	0,0	2,1	0,0
15	13,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
16	44,8	0,0	0,0	0,0	0,0	2,6	0,0	0,0	0,0	0,0	0,0	0,0
17	0,0	0,0	0,0	0,9	3,1	0,0	0,0	0,0	0,0	0,0	4,7	0,0
18	0,0	0,0	0,0	4,0	0,0	2,0	0,0	1,9	0,0	0,0	16,7	0,0
19	0,0	0,0	0,0	4,0	0,0	0,0	0,0	29,5	0,0	0,0	0,0	0,0
20	0,0	0,0	0,0	2,6	0,0	0,0	0,0	2,0	0,0	0,0	0,0	0,0
21	0,0	0,0	0,0	5,6	0,0	0,0	0,0	64,0	0,0	0,0	0,0	0,0
22	0,0	0,0	0,0	0,0	0,0	0,0	40,6	10,6	0,0	0,0	5,2	0,0
23	0,0	0,0	0,0	0,0	0,0	0,0	1,0	3,8	0,0	0,0	1,5	0,0
24	1,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	28,4	0,0	0,0	5,2
25	0,0	0,0	0,0	22,3	5,2	0,0	0,0	0,0	25,6	6,7	0,0	5,6
26	8,4	0,0	0,0	3,3	2,8	0,0	2,2	0,0	0,0	0,0	2,8	2,3
27	0,0	0,0	5,0	0,0	0,0	0,0	3,2	0,0	0,0	0,0	17,7	0,0
28	0,0	0,0	1,4	0,7	4,0	0,0	3,0	8,8	17,8	10,0	0,8	0,0
29	0,0	0,0	0,0	2,6	5,6	0,0	0,0	0,0	0,0	0,0	0,0	3,4
30	0,0		0,0	2,2	0,0	14,6	0,0	0,0	0,0	0,0	9,8	0,0
31	0,0		0,0			0,0		0,0		0,0		0,0

DATE	YEAR 1996 RAIN (mm/m^2)											
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	5,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
2	0,0	0,0	1,1	6,3	5,8	0,0	0,0	0,0	19,8	0,0	0,0	31,2
3	0,0	0,0	0,0	0,0	10,0	0,0	0,0	0,0	55,1	0,0	0,0	0,0
4	0,0	0,0	0,0	0,0	7,6	0,0	0,0	0,0	4,8	0,0	0,0	0,0
5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
6	0,0	0,0	0,0	3,0	1,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0
7	0,0	0,0	0,0	0,0	4,0	7,8	0,0	0,0	0,0	0,0	0,0	0,0
8	0,0	0,0	0,0	0,0	2,7	0,0	0,0	16,2	0,0	0,0	0,0	0,0
9	0,0	0,0	0,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,0	0,0
10	0,0	0,0	16,2	3,3	0,0	1,5	0,0	0,0	0,0	0,0	0,0	0,0
11	0,0	0,0	37,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
12	0,0	0,0	2,0	0,0	0,0	0,0	0,0	17,4	0,0	0,0	0,0	0,0
13	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,6
14	0,0	0,0	20,6	0,0	6,6	0,0	46,0	0,0	0,0	0,0	0,0	0,0
15	0,0	0,0	10,6	0,0	0,0	0,0	2,3	0,0	0,0	0,0	0,0	0,0
16	0,0	0,0	38,1	0,0	2,6	0,0	40,0	0,0	0,0	0,0	0,0	0,0
17	0,0	0,0	10,8	3,1	0,0	0,0	0,0	0,0	0,0	4,6	0,0	0,0
18	0,0	0,0	63,2	0,0	2,0	0,0	28,4	0,0	0,0	0,0	0,0	0,0
19	0,0	0,0	0,0	0,0	0,0	0,0	2,4	0,0	0,0	0,0	0,0	0,0
20	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,2	0,0
21	0,0	0,0	0,0	0,0	0,0	0,0	42,4	0,0	0,0	0,0	1,0	0,0
22	0,0	0,0	0,0	0,0	0,0	40,6	2,5	0,0	0,0	7,0	0,0	0,0
23	0,0	0,0	0,0	0,0	0,0	1,0	3,6	0,0	0,0	2,0	0,0	0,0
24	0,0	0,0	0,0	0,0	0,0	0,0	52,0	0,0	0,0	1,0	0,0	0,0
25	0,0	0,0	0,0	5,2	0,0	0,0	0,0	0,0	0,0	0,0	10,8	0,0
26	0,0	0,0	0,0	2,8	0,0	2,2	3,0	0,0	0,0	0,0	1,2	0,0
27	0,0	0,0	1,2	0,0	0,0	3,2	32,5	0,0	0,0	0,0	0,0	0,0
28	0,0	0,0	7,8	4,0	0,0	3,0	32,5	0,0	0,0	0,8	0,8	0,0
29	0,0		0,0	5,6	0,0	0,0	14,0	0,0	0,0	1,4	6,0	0,0
30	0,0		1,1	0,0	14,6	0,0	0,0	46,8	0,0	2,2	0,0	0,0
31	0,0		52,0		0,0			0,0		3,2		0,0

DATE	YEAR 1997 RAIN (mm/m^2)											
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	79,0	0,0	0,0	12,1	0,0	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,0	61,6	0,0	1,2	0,0	0,0	3,6	3,6	0,0
3	0,0	0,0	0,0	56,0	0,0	0,0	25,3	24,3	0,0	0,0	0,0	7,3
4	0,0	0,0	0,0	41,0	0,0	0,0	9,0	50,6	0,0	0,0	0,0	10,1
5	0,0	0,0	0,0	0,0	5,4	0,0	0,0	50,5	0,0	0,0	0,0	12,9
6	0,0	0,0	0,0	0,0	3,2	0,0	0,0	21,2	4,1	0,0	0,0	4,4
7	0,0	0,0	0,0	45,2	0,0	0,0	58,0	22,3	0,0	0,0	0,0	0,0
8	0,0	0,0	0,0	6,8	0,0	0,0	9,6	31,2	0,0	0,0	0,0	0,0
9	0,0	0,0	0,0	16,6	0,0	0,0	4,6	9,0	0,0	0,0	0,0	0,0
10	0,0	0,0	0,0	75,4	0,0	0,0	0,0	0,0	0,0	8,8	8,8	21,0
11	0,0	0,0	0,0	65,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,0
12	0,0	0,0	0,0	0,0	1,2	0,0	0,0	0,0	0,0	5,2	5,2	0,0
13	0,0	0,0	0,0	2,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	8,1
14	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,3	4,3	64,0
15	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
16	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
17	0,0	0,0	0,0	0,0	0,0	8,6	6,8	0,0	0,0	0,0	0,0	28,6
18	0,0	0,0	0,0	2,2	0,0	12,0	0,0	0,0	0,0	6,0	6,0	88,4
19	0,0	0,0	0,0	0,0	0,0	30,1	0,0	1,8	0,0	12,0	12,0	7,2
20	0,0	0,0	0,0	0,0	0,0	4,8	0,0	0,0	0,0	10,0	10,0	4,5
21	0,0	0,0	0,0	21,0	0,0	3,6	1,9	0,0	0,0	6,0	6,0	0,2
22	0,0	0,0	0,0	26,0	0,0	0,0	0,3	9,4	0,0	18,0	18,0	8,0
23	0,0	0,0	0,0	0,0	0,0	0,0	90,1	1,3	0,0	2,0	2,0	20,8
24	0,0	0,0	0,0	6,8	0,0	0,0	0,0	25,6	0,0	0,0	0,0	0,0
25	0,0	0,0	0,0	63,0	0,0	0,0	15,0	0,0	0,0	0,0	0,0	10,2
26	0,0	0,0	0,0	4,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	25,7
27	0,0	0,0	0,0	2,3	0,0	0,0	39,0	0,0	0,0	0,0	0,0	3,5
28	0,0	0,0	0,0	14,4	0,0	0,0	15,8	0,0	0,0	10,7	10,7	1,4
29	0,0		0,0	1,4	0,0	0,0	0,0	0,0	0,0	3,0	3,0	2,0
30	0,0		0,0	0,0	0,0	27,4	0,0	0,0	0,0	12,9	12,9	22,8
31	0,0		89,0		0,0		0,0	0,0		0,0	0,0	

	YEAR 1998 RAIN (mm/m^2)											
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4	0,0	0,0
2	0,0	0,0	0,0	0,0	0,0	0,0	4,8	20,9	0,0	55,4	0,0	0,0
3	2,3	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,0	27,2	0,0	0,0
4	86,5	0,0	0,0	0,0	20,8	0,0	2,7	0,0	0,0	0,0	0,0	0,0
5	121,2	0,0	0,0	0,0	50,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
6	0,7	0,0	0,0	17,1	5,2	28,8	0,0	0,0	0,0	1,5	0,0	0,0
7	3,0	0,0	0,0	16,2	0,0	3,6	0,0	9,8	0,0	0,0	0,0	0,0
8	15,0	0,0	0,0	2,4	16,5	0,0	0,0	30,2	0,0	0,0	0,0	0,0
9	7,0	0,0	8,6	0,0	5,2	4,2	2,0	1,1	0,0	0,0	0,0	0,0
10	0,0	0,0	0,0	18,6	0,9	49,9	29,4	0,0	0,0	0,0	0,0	0,0
11	0,0	53,0	0,0	0,0	0,0	0,0	0,0	0,0	6,3	2,3	0,0	0,0
12	40,0	3,6	0,0	0,0	25,1	0,0	0,0	31,0	0,0	0,0	3,9	0,0
13	0,0	0,1	0,0	0,0	10,0	2,8	9,8	0,0	0,0	0,0	0,0	0,0
14	4,5	0,0	0,0	0,0	1,6	0,0	0,0	3,5	0,0	0,0	0,0	0,0
15	1,0	0,0	0,0	0,0	3,6	0,0	11,0	0,0	11,2	0,0	0,0	0,0
16	4,2	0,0	0,0	0,0	0,0	10,3	3,8	7,7	0,0	0,0	0,0	0,0
17	45,5	0,0	0,0	0,0	16,4	0,0	2,7	12,5	11,8	0,0	0,0	0,0
18	0,0	0,0	0,0	0,0	0,0	0,0	7,1	10,2	5,8	1,7	0,0	0,0
19	0,0	0,8	0,0	0,0	0,0	0,0	46,3	0,0	0,0	1,8	0,0	0,0
20	0,0	3,4	0,0	24,8	0,0	0,0	59,4	15,9	0,0	18,0	0,0	0,0
21	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
22	0,0	0,0	0,0	2,4	0,7	0,0	11,5	0,0	0,0	0,0	0,0	0,0
23	0,0	0,0	0,0	0,0	49,0	0,0	16,6	0,0	0,0	0,0	0,0	0,0
24	0,0	0,0	0,0	0,0	18,4	0,0	27,6	0,9	13,0	0,0	0,0	0,0
25	0,0	0,0	0,0	0,0	16,0	10,9	4,4	11,2	0,0	0,0	0,0	0,0
26	0,0	0,0	0,0	6,2	14,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
27	0,0	0,0	0,0	6,3	11,1	31,0	0,0	4,7	0,0	0,0	0,0	0,0
28	9,8	0,0	0,0	0,0	23,3	14,4	0,0	5,2	0,0	0,0	0,0	0,0
29	15,9		0,0	0,0	6,1	3,9	4,6	0,0	0,0	0,0	0,0	0,0
30	2,2		0,0	0,0	0,0	11,4	18,3	2,6	7,0	0,0	0,0	0,0
31	0,0		0,0		0,0		0,8	0,0		0,0		0,0

	YEAR 1999 RAIN (mm/m^2)											
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	5,7	0,0	0,0	0,0	1,1	17,0	1,0	25,0	0,0
2	0,0	0,0	1,1	6,3	5,8	0,0	0,0	17,2	0,0	0,0	17,4	0,0
3	0,0	0,0	0,0	0,0	10,0	0,0	0,0	19,1	1,2	27,4	1,8	0,0
4	0,0	0,0	0,0	0,0	7,6	0,0	0,0	1,3	29,0	2,4	1,0	0,0
5	0,0	0,0	0,0	0,0	0,0	0,0	5,9	0,0	0,8	0,0	8,0	0,0
6	0,0	0,0	0,0	3,0	1,4	0,0	0,0	4,0	0,0	0,0	0,0	0,0
7	0,0	0,0	0,0	0,0	4,0	7,8	0,0	2,1	0,0	0,0	0,0	0,0
8	0,0	0,0	0,0	0,0	2,7	0,0	0,0	11,0	29,2	0,0	0,0	0,0
9	0,0	0,0	0,8	0,0	0,0	0,0	0,8	13,0	1,8	0,0	0,0	0,0
10	0,0	0,0	16,2	3,3	0,0	1,5	0,0	15,6	0,0	0,0	14,5	5,8
11	0,0	0,0	37,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
12	0,0	0,0	2,0	0,0	0,0	0,0	29,4	13,6	0,0	0,0	0,0	0,0
13	0,0	0,0	0,0	0,0	0,0	0,0	0,0	18,5	0,0	0,0	30,2	0,0
14	0,0	0,0	20,6	0,0	6,6	0,0	0,0	8,4	0,0	0,0	2,2	0,8
15	0,0	0,0	10,6	0,0	0,0	0,0	0,0	0,8	0,0	0,0	10,4	8,3
16	0,0	0,0	38,1	0,0	2,6	0,0	0,0	0,0	0,0	0,0	2,8	0,0
17	0,0	0,0	10,8	3,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
18	0,0	0,0	63,2	0,0	2,0	0,0	1,9	11,4	0,0	0,0	12,8	0,0
19	0,0	0,0	0,0	0,0	0,0	0,0	29,5	13,2	2,2	0,0	13,0	0,0
20	0,0	0,0	0,0	0,0	0,0	0,0	2,0	0,0	0,0	0,0	0,0	0,0
21	0,0	0,0	0,0	0,0	0,0	0,0	64,0	0,0	0,0	0,0	0,0	0,0
22	0,0	0,0	0,0	0,0	0,0	40,6	10,6	0,0	0,0	0,0	0,0	0,0
23	0,0	0,0	0,0	0,0	0,0	1,0	3,8	0,8	2,8	0,0	2,0	0,0
24	0,0	0,0	0,0	0,0	0,0	0,0	0,0	18,0	0,0	1,0	0,0	0,0
25	0,0	0,0	0,0	5,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
26	0,0	0,0	0,0	2,8	0,0	2,2	0,0	5,8	0,0	2,2	3,2	0,0
27	0,0	0,0	1,2	0,0	0,0	3,2	0,0	3,2	0,0	8,8	0,0	0,0
28	0,0	0,0	7,8	4,0	0,0	3,0	8,8	48,0	0,0	34,6	9,6	0,0
29	0,0		0,0	5,6	0,0	0,0	0,0	0,0	0,0	0,0	1,6	0,0
30	0,0		1,1	0,0	14,6	0,0	0,0	0,0	0,0	25,0	0,0	0,0
31	0,0		52,0		0,0		0,0	2,4		4,2		0,0

YEAR 2000 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	1,4	4,5		0,0	0,0	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,0	2,1	0,0	0,0	0,0	0,0	0,0	4,1	2,4
3	2,0	0,0	0,0	5,4	26,0	0,0	3,8	0,0	0,0	0,0	0,0	0,0
4	0,0	0,0	48,0	0,0	18,3	0,0	10,2	2,0	0,0	0,0	0,0	0,0
5	0,0	0,0	25,4	0,0	6,7	0,0	0,0	0,0	0,0	1,2	0,0	0,0
6	0,0	0,0	0,0	0,0	35,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
7	0,0	0,0	0,0	0,0	1,1	0,0	3,0	14,0	0,0	0,0	0,0	0,0
8	0,0	0,0	0,0	0,0	72,0	2,2	6,3	0,0	0,0	0,0	0,0	0,0
9	0,0	0,0	0,0	0,0	0,0	0,0	6,8	0,0	0,0	0,0	1,0	0,0
10	1,0	0,0	0,0	0,0	0,0	3,0	0,0	0,0	0,0	0,0	0,0	0,0
11	6,5	0,0	42,1	0,0	13,6	45,4	5,6	9,0	0,0	0,0	1,2	53,4
12	61,0	0,0	0,0	1,6	10,8	0,0	0,0	7,0	0,0	7,6	0,0	4,6
13	13,3	0,0	0,0	0,0	0,0	0,0	0,0	22,0	0,0	0,0	0,0	0,0
14	1,2	0,0	0,0	0,0	0,0	0,0	0,0	28,0	0,0	5,8	0,0	0,0
15	12,0	0,0	0,0	3,3	5,8	0,0	16,4	0,0	1,8	0,0	0,0	0,0
16	0,0	0,0	0,0	12,0	0,0	0,0	1,6	59,8	2,0	11,4	0,0	0,0
17	0,0	1,1	0,0	0,0	0,0	0,0	13,0	27,2	0,0	2,8	0,0	9,7
18	0,0	1,8	0,0	5,4	2,2	0,0	0,0	45,0	0,0	1,0	77,2	13,4
19	0,0	0,0	0,0	0,0	0,0	0,0	17,8	17,0	0,0	8,0	0,0	0,0
20	0,0	0,0	0,0	3,8	0,0	0,0	3,8	15,4	0,0	1,8	11,3	0,0
21	0,0	0,0	4,1	25,4	0,0	0,0	10,2	19,8	0,0	6,0	5,5	0,0
22	0,0	0,0	0,0	8,8	0,0	1,4	30,6	11,0	0,0	36,5	0,0	0,0
23	0,0	0,0	3,9	17,0	0,0	7,6	77,8	0,0	0,0	3,6	22,3	0,0
24	0,0	0,0	0,0	0,0	0,0	0,6	41,3	0,0	0,0	1,2	5,6	0,0
25	0,0	0,0	0,0	0,0	0,0	54,6	8,8	1,4	0,0	1,2	6,4	0,0
26	0,0	0,0	0,0	0,0	0,0	22,4	6,0	0,0	0,0	0,0	0,0	0,0
27	0,0	0,0	0,0	0,0	0,0	5,8	0,0	0,0	0,0	0,0	0,0	0,0
28	0,0	0,0	1,0	6,2	0,0	7,8	0,0	23,2	0,0	0,0	0,0	0,0
29	0,0	0,0	0,0	0,0	0,0	2,7	0,0	0,0	15,4	0,0	0,0	0,0
30	0,0		0,0	18,2	0,0	13,5	23,8	0,0	7,6	0,0	0,0	0,0
31	0,0		0,0		0,0		6,6	0,0		2,9		0,0

YEAR 2001 RAIN (mm/m^2)											
JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
0,0	0,0	0,0	6,6	1,1	7,5	4,2	1,1	17,0	1,0	25,0	0,0
0,0	0,0	0,0	2,1	1,0	7,8	5,9	17,2	0,0	0,0	17,4	0,0
0,0	0,0	0,0	0,0	1,1	0,0	0,0	19,1	1,2	27,4	1,8	0,0
0,0	0,0	0,0	1,2	2,2	0,0	0,0	1,3	29,0	2,4	1,0	0,0
0,0	0,0	0,0	0,0	3,4	0,0	0,0	0,0	0,8	0,0	8,0	0,0
2,6	0,0	0,0	6,2	0,0	0,0	0,0	4,0	0,0	0,0	0,0	0,0
0,0	0,0	15,6	2,0	23,4	2,6	0,0	2,1	0,0	0,0	0,0	0,0
0,0	0,0	1,2	12,0	1,2	0,0	0,0	11,0	29,2	0,0	0,0	0,0
0,0	29,6	3,5	2,2	9,0	0,0	0,0	13,0	1,8	0,0	0,0	0,0
0,0	11,5	0,0	0,0	0,0	2,0	0,0	15,6	0,0	0,0	14,5	5,8
3,4	0,0	0,0	0,0	0,0	4,0	9,6	0,0	0,0	0,0	0,0	0,0
2,0	0,0	0,0	0,0	0,0	9,5	4,1	13,6	0,0	0,0	0,0	0,0
1,2	0,0	0,0	0,0	2,2	6,4	32,2	18,5	0,0	0,0	30,2	0,0
0,0	0,0	5,4	0,0	0,0	0,2	9,8	8,4	0,0	0,0	2,2	0,8
0,0	0,0	0,0	0,0	0,0	23,8	0,0	0,8	0,0	0,0	10,4	8,3
0,0	0,0	0,0	7,2	8,0	0,0	0,0	0,0	0,0	0,0	2,8	0,0
0,0	0,0	0,0	1,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	7,7	0,0	3,0	0,0	1,2	11,4	0,0	0,0	12,8	0,0
0,0	0,0	0,0	0,0	0,0	0,0	9,1	13,2	2,2	0,0	13,0	0,0
0,0	0,0	0,0	1,8	0,0	0,0	33,0	0,0	0,0	0,0	0,0	0,0
1,4	0,0	0,0	0,0	0,0	0,0	9,8	0,0	0,0	0,0	0,0	0,0
7,6	0,0	0,0	4,2	0,0	0,0	2,3	0,0	0,0	0,0	0,0	0,0
0,6	0,0	0,0	8,8	0,0	0,0	10,6	0,8	2,8	0,0	2,0	0,0
33,5	0,0	1,6	2,0	0,0	0,0	23,9	18,0	0,0	1,0	0,0	0,0
45,8	0,0	41,8	8,2	2,8	0,0	57,7	0,0	0,0	0,0	0,0	0,0
0,0	0,0	1,7	0,0	0,0	3,0	5,1	5,8	0,0	2,2	3,2	0,0
2,8	0,0	33,0	16,5	0,0	9,0	41,7	3,2	0,0	8,8	0,0	0,0
0,0	0,0	9,8	8,2	1,6	6,8	0,0	48,0	0,0	34,6	9,6	0,0
0,0		5,2	21,4	0,0	11,0	0,0	0,0	0,0	0,0	1,6	0,0
0,0		2,0	0,0	0,0	0,0	5,1	0,0	0,0	25,0	0,0	0,0
0,0		25,5		7,6		7,7	2,4		4,2		0,0

YEAR 2002 RAIN (mm/m^2)

DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	1,4	4,5	0,0	0,0	10,5	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,0	2,1	0,0	0,0	1,3	0,0	10,0	0,0	0,0
3	2,0	0,0	0,0	5,4	26,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
4	0,0	0,0	48,0	0,0	18,3	0,0	0,0	11,8	0,0	6,5	0,0	0,0
5	0,0	0,0	25,4	0,0	6,7	0,0	0,0	3,8	0,0	3,7	8,8	10,8
6	0,0	0,0	0,0	0,0	35,1	0,0	0,0	8,1	0,0	0,0	9,4	0,0
7	0,0	0,0	0,0	0,0	1,1	0,0	0,0	0,0	0,0	0,0	21,6	0,0
8	0,0	0,0	0,0	0,0	72,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	10,0	0,0	4,0	0,0	0,0
10	1,0	0,0	0,0	0,0	0,0	0,0	0,0	17,6	0,0	0,0	0,0	3,3
11	6,5	0,0	42,1	0,0	13,6	0,0	0,0	23,2	0,0	2,0	1,2	0,0
12	61,0	0,0	0,0	1,6	10,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0
13	13,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,1	7,7
14	1,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	14,1	0,0
15	12,0	0,0	0,0	3,3	5,8	0,0	0,0	0,0	0,0	0,0	2,1	0,0
16	0,0	0,0	0,0	12,0	0,0	33,0	1,6	0,0	2,3	0,0	0,0	0,0
17	0,0	1,1	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	6,8
18	0,0	1,8	0,0	5,4	2,2	0,0	0,0	1,0	1,8	0,0	0,0	0,0
19	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
20	0,0	0,0	0,0	3,8	0,0	6,4	0,0	0,0	0,0	0,0	0,0	0,0
21	0,0	0,0	4,1	25,4	0,0	2,1	0,0	0,0	0,0	0,0	0,0	0,0
22	0,0	0,0	0,0	8,8	0,0	12,2	0,8	0,0	0,0	0,0	0,0	0,0
23	0,0	0,0	3,9	17,0	0,0	6,1	0,7	21,0	0,0	0,0	4,0	0,0
24	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,8	0,0	0,0	0,0	23,2
25	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	11,2
26	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,0	4,0	0,0	20,0
27	0,0	0,0	0,0	0,0	0,0	3,6	0,0	0,0	0,0	0,0	0,0	51,6
28	0,0	0,0	1,0	6,2	0,0	0,0	0,0	0,0	0,0	3,5	0,0	12,2
29	0,0		0,0	0,0	0,0	0,0	0,0	27,8	0,0	0,0	0,0	0,0
30	0,0		0,0	18,2	0,0	0,0	20,2	0,0	0,0	0,0	0,0	0,0
31	0,0		0,0		0,0		17,6	0,0		4,3		0,0

YEAR 2003 RAIN (mm/m^2)

DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	16,4	0,0	0,0	0,0	34,6	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,0	3,6	0,0	0,0	0,6	0,0	0,0	0,0	0,0
3	0,0	0,0	0,0	0,0	6,2	0,0	18,9	4,5	0,0	0,0	0,0	0,0
4	30,0	0,0	0,0	0,0	64,4	0,0	0,0	19,0	0,0	0,0	0,0	0,0
5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
6	0,0	0,0	0,0	0,0	4,6	0,0	2,2	0,0	0,0	0,0	0,0	0,0
7	0,0	0,0	0,0	0,0	51,6	0,0	11,5	0,0	0,0	0,0	0,0	0,0
8	0,0	0,0	0,0	0,0	1,4	0,0	35,6	0,0	4,0	0,0	0,0	0,0
9	0,0	0,0	0,0	0,0	35,8	0,0	0,0	0,0	0,0	0,0	0,0	73,0
10	0,0	0,0	0,0	0,0	21,0	34,4	0,0	0,0	0,0	0,0	0,0	12,0
11	0,0	0,0	0,0	0,0	0,0	16,0	0,0	0,0	0,0	0,0	0,0	0,0
12	0,0	0,0	0,0	0,0	5,6	16,4	0,0	0,0	0,0	0,0	0,0	0,0
13	0,0	0,0	0,0	0,0	13,2	0,0	0,0	0,0	0,0	4,4	0,0	0,0
14	0,0	0,0	0,0	0,0	1,4	0,0	0,0	28,7	0,0	0,0	6,7	0,0
15	0,0	0,0	0,0	2,2	23,8	12,5	0,0	0,0	0,0	0,0	0,0	0,0
16	0,0	0,0	0,0	0,0	0,0	15,0	0,0	37,1	0,0	0,0	0,0	0,0
17	0,0	0,0	0,0	12,2	26,8	11,0	8,6	32,3	0,0	0,0	7,8	0,0
18	0,0	0,0	0,0	0,1	0,0	0,0	16,0	62,3	0,0	7,8	0,0	0,0
19	0,0	0,0	0,0	7,0	0,0	11,9	1,0	33,9	0,0	1,4	0,0	0,0
20	0,0	0,0	0,0	6,8	0,0	0,0	5,0	52,8	0,0	0,0	0,0	0,0
21	5,2	0,0	0,0	4,8	0,0	0,0	20,8	8,1	0,0	0,0	1,4	0,0
22	0,0	0,0	0,0	41,0	12,8	0,0	4,4	0,8	0,0	2,0	0,0	0,0
23	0,0	0,0	0,0	47,0	0,0	0,0	0,0	8,0	0,0	0,0	0,0	0,0
24	0,0	0,0	14,4	22,0	30,4	0,0	0,0	0,0	0,0	1,1	0,0	0,0
25	0,0	0,0	2,6	11,8	0,0	0,0	0,0	9,3	0,0	0,0	0,0	0,0
26	0,0	0,0	0,0	3,4	2,2	0,0	1,9	19,0	0,0	0,0	0,0	0,0
27	0,0	0,0	4,2	34,2	0,0	0,0	0,0	16,4	0,0	0,0	6,0	0,0
28	0,0	0,0	0,0	37,0	4,1	12,0	14,4	43,0	0,0	0,0	0,0	0,0
29	0,0		4,6	22,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
30	0,0		8,0	61,8	2,5	0,0	4,4	0,0	0,0	0,0	0,0	0,0
31	0,0		8,2		1,2		2,6	0,0		13,8		0,0

	YEAR 2004 RAIN (mm/m^2)											
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	44,6	106,7	0,0	0,0	34,6	0,0	1,4	10,5	0,0
2	0,0	0,0	0,0	3,3	60,6	0,0	0,0	8,0	0,0	0,0	4,1	0,0
3	0,0	14,3	0,0	0,0	17,6	0,0	0,0	1,6	0,0	1,5	9,6	0,0
4	0,0	0,0	0,0	7,5	30,4	5,6	0,0	2,6	0,5	0,0	54,5	0,0
5	0,0	0,0	0,0	27,2	0,0	0,0	20,5	4,0	0,0	0,0	0,0	0,0
6	0,0	0,0	0,0	6,2	3,2	0,0	11,4	0,0	0,0	0,0	8,5	0,0
7	0,0	0,0	0,0	2,7	14,4	0,0	5,4	0,0	0,0	0,0	7,8	0,0
8	1,4	0,0	0,0	0,0	1,0	0,0	1,8	37,5	0,0	0,0	1,0	1,5
9	0,0	1,4	0,0	0,0	0,0	5,9	0,0	13,0	0,0	0,5	0,0	0,0
10	0,0	0,0	0,0	40,1	1,0	0,0	0,0	1,5	0,0	0,0	0,0	0,0
11	0,0	0,0	0,0	53,8	3,0	0,0	0,0	21,6	0,0	0,0	0,0	0,0
12	0,0	0,0	37,4	5,6	0,0	0,0	0,0	38,9	2,5	0,0	1,8	0,0
13	0,0	0,0	12,7	1,9	0,0	0,0	0,0	18,2	0,5	0,0	0,5	0,0
14	22,0	0,0	0,0	2,0	0,0	0,0	10,0	5,8	1,3	0,0	8,9	0,0
15	13,0	0,0	0,0	0,0	0,0	1,6	0,0	34,0	0,0	0,5	3,6	0,0
16	44,8	0,0	0,0	0,0	2,2	12,5	0,0	1,5	0,0	0,0	0,0	0,0
17	0,0	0,0	0,0	0,9	0,0	18,2	0,0	0,0	0,0	0,0	0,0	11,0
18	0,0	0,0	0,0	4,0	0,0	0,0	0,0	12,0	0,0	0,0	0,0	0,0
19	0,0	0,0	0,0	4,0	0,0	2,0	2,0	3,5	0,0	1,9	0,0	0,0
20	0,0	0,0	0,0	2,6	0,0	2,5	13,6	0,0	0,0	1,7	0,8	0,0
21	0,0	0,0	0,0	5,6	0,0	10,4	0,0	0,0	0,0	0,0	0,0	0,0
22	0,0	0,0	0,0	0,0	0,0	0,0	2,4	0,0	0,8	0,0	70,0	5,5
23	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4	0,0	0,0	0,0
24	1,4	0,0	0,0	0,0	0,0	0,0	7,3	0,0	0,0	0,0	0,0	0,0
25	0,0	0,0	0,0	22,3	0,0	0,0	0,0	0,0	0,5	0,0	0,0	0,0
26	8,4	0,0	0,0	3,3	0,0	0,0	0,0	0,0	4,6	0,0	10,4	0,0
27	0,0	0,0	5,0	0,0	0,0	0,0	18,6	0,5	26,1	8,0	0,0	0,0
28	0,0	0,0	1,4	0,7	0,0	0,0	13,0	15,0	15,8	20,5	0,0	0,0
29	0,0	0,0	0,0	2,6	0,0	0,0	7,7	0,0	49,3	0,5	0,0	0,0
30	0,0		0,0	2,2	14,2	0,0	80,2	3,8	0,0	0,5	0,0	0,0
31	0,0		0,0		7,2		0,0	0,0		0,0		0,0

YEAR 2005 RAIN (mm/m^2)											
JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
0,0	0,0	13,8	0,0	12,1	0,0	0,0	9,3	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	1,5	0,0	0,0	0,0	0,0	1,5	0,0	0,0
0,0	0,0	8,8	0,0	22,8	0,0	0,0	0,0	6,8	0,0	1,9	0,0
0,0	0,0	0,0	0,0	2,3	0,0	0,0	0,0	0,0	0,0	1,4	0,0
0,0	0,0	0,0	5,2	15,4	0,0	7,8	19,6	0,0	0,0	0,0	0,0
0,0	0,0	0,0	56,6	14,5	0,0	4,5	9,4	18,6	1,3	1,0	0,0
0,0	0,0	0,0	14,8	0,0	0,0	22,8	0,0	38,7	1,1	2,8	0,0
0,0	0,0	0,0	0,0	23,2	0,0	36,0	0,0	5,0	0,0	0,0	0,0
0,0	0,0	0,0	2,5	9,3	0,0	0,0	0,0	10,7	0,0	0,0	0,0
0,0	0,0	0,0	0,0	0,0	21,0	0,6	0,0	5,6	0,0	0,0	4,3
0,0	0,0	0,0	1,1	0,0	1,8	0,0	7,8	4,7	2,0	0,0	6,0
0,0	0,0	0,0	0,0	0,0	0,0	0,0	12,0	48,2	0,0	0,5	0,0
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	25,5	0,0	0,0	0,0
0,0	0,0	0,0	0,0	27,3	0,0	0,0	0,0	5,6	0,0	2,2	0,0
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	5,8	0,0	0,0	2,2	8,1	0,0	0,0	0,0
0,0	0,0	0,0	0,0	8,0	0,0	21,0	3,0	44,0	0,0	0,0	0,0
0,0	0,0	4,7	0,0	0,5	0,0	6,0	3,2	4,5	0,0	2,4	0,0
0,0	0,0	0,5	0,0	0,0	15,7	4,0	48,0	4,8	0,0	0,0	0,0
0,0	0,0	12,2	0,0	0,0	15,2	0,0	1,7	0,0	0,0	0,0	0,0
0,0	0,0	1,5	0,0	0,0	0,8	31,5	0,8	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	18,5	17,0	4,9	18,5	0,0	0,0	1,5	0,0
0,0	0,0	71,5	3,0	0,0	0,0	0,0	0,8	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	13,7	0,0	13,5	2,9	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,0	0,0	0,0	3,8	0,0	0,0	0,0	0,0	0,0
32,0	0,0	0,0	0,0	20,5	0,0	3,2	0,0	0,0	0,0	0,0	0,0
25,0	0,0	0,0	0,0	0,0	0,0	0,0	3,7	0,0	0,0	0,0	0,0
0,0	0,0	0,0	12,0	32,5	12,2	0,0	28,6	0,0	0,0	0,0	0,0
6,1		0,0	6,3	9,0	0,0	10,5	0,0	0,0	0,0	0,0	0,0
29,1		0,0	2,8	19,9	12,2	6,6	0,0	0,0	0,0	0,0	0,0
3,5		0,0		7,0		13,1	0,0		0,0		0,0

YEAR 2006 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	8,4	0,0	0,0	0,0	0,0	0,0	0,7	1,2	4,9	17,5
2	0,0	0,0	5,5	0,0	0,0	0,5	0,0	7,2	1,2	2,5	24,5	10,0
3	0,0	0,0	48,9	37,2	0,6	0,0	0,0	0,0	17,7	0,0	0,0	0,5
4	0,0	0,0	21,0	17,8	0,0	0,0	0,5	3,5	0,0	0,0	0,0	0,0
5	0,0	0,0	7,0	83,3	0,0	0,0	2,8	1,2	0,0	0,0	0,0	0,0
6	0,0	0,0	3,0	18,5	0,0	0,0	4,5	47,0	0,0	6,2	1,7	0,0
7	0,0	0,0	0,0	7,7	0,0	0,0	9,6	2,5	0,0	0,0	0,0	11,8
8	0,0	0,0	5,9	0,9	0,0	2,9	3,9	12,5	0,0	0,0	0,5	0,5
9	0,0	0,0	0,0	1,3	0,0	0,0	22,7	24,1	8,0	0,0	20,0	0,0
10	0,0	0,0	0,5	0,0	0,0	0,0	1,0	15,0	0,0	0,0	1,2	0,0
11	0,0	0,0	0,0	0,0	0,7	0,0	4,8	2,3	0,0	0,0	4,5	0,0
12	0,0	0,0	0,0	0,0	0,0	6,2	1,0	0,0	0,0	0,0	0,0	0,0
13	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,0
14	0,0	0,0	0,0	0,0	5,0	0,0	0,0	0,7	0,0	0,0	1,3	1,2
15	5,0	0,0	0,0	0,0	11,8	0,0	0,0	25,6	0,0	0,0	0,0	0,0
16	0,0	0,0	0,0	0,0	8,9	0,0	0,0	15,8	0,0	0,0	13,7	0,0
17	3,4	0,0	0,0	8,0	4,0	0,0	0,0	2,0	0,0	0,0	11,2	0,0
18	0,0	0,0	0,0	0,0	1,2	0,0	0,0	3,2	1,3	0,0	0,0	0,0
19	0,0	0,0	0,0	1,0	0,5	0,5	0,0	6,4	0,0	0,0	11,5	0,0
20	0,0	0,0	0,0	0,0	6,2	1,0	1,2	0,0	0,5	4,0	47,1	0,0
21	3,4	0,0	0,0	22,0	0,0	2,0	1,9	20,5	0,0	4,0	38,5	0,0
22	16,2	0,0	0,0	0,0	2,0	0,7	0,0	7,0	2,3	8,8	42,6	0,0
23	0,0	0,0	0,5	9,5	0,0	0,0	1,8	10,6	0,0	2,0	17,0	8,6
24	0,0	0,0	0,0	10,8	0,0	0,0	0,0	2,0	0,0	21,3	16,5	4,6
25	0,0	2,3	9,4	2,1	0,7	3,8	0,0	1,6	0,0	5,1	8,5	0,0
26	0,0	0,0	0,5	0,0	0,0	9,2	0,0	1,8	0,0	0,5	26,0	1,6
27	0,0	9,0	0,0	0,0	0,0	1,9	0,0	15,0	0,0	4,5	4,6	32,4
28	0,0	1,1	0,0	0,0	0,0	54,0	1,3	13,0	0,0	0,0	0,0	62,0
29	0,0		0,0	0,0	8,2	10,0	22,8	0,0	0,0	2,4	56,5	7,1
30	0,0		0,0	0,0	0,5	0,0	6,0	0,0	0,9	34,3	57,6	8,8
31	0,0		1,5		2,7		0,0	0,0		14,0		15,5

YEAR 2007 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	32,7	5,6	0,0	0,0	69,8	12,8	20,7	7,5	45,6	0,0	0,0
2	0,0	49,2	0,0	0,0	0,0	15,8	8,8	3,4	6,0	0,0	0,0	0,0
3	0,0	16,6	0,0	0,0	0,0	40,0	5,5	0,0	3,7	4,3	0,0	0,0
4	0,0	7,5	0,0	0,0	0,0	2,7	14,0	0,7	13,7	0,0	0,0	0,0
5	7,2	10,0	0,0	0,0	0,0	0,0	3,8	33,4	38,2	1,6	1,8	0,0
6	0,0	3,9	0,0	0,0	1,2	0,0	3,0	6,9	13,6	0,0	0,0	0,0
7	0,0	0,0	0,0	0,0	5,5	0,0	5,3	10,5	1,2	0,0	0,0	0,0
8	0,0	0,0	0,0	5,7	2,6	4,8	0,0	37,4	0,0	0,0	0,8	2,7
9	0,0	0,0	0,0	0,0	0,0	0,0	0,8	12,8	1,7	0,0	0,0	7,0
10	0,0	0,0	0,0	0,0	0,0	2,4	0,0	0,8	9,7	0,0	0,0	0,0
11	0,0	0,0	4,4	2,9	0,0	1,0	0,0	70,0	41,1	0,0	1,0	0,0
12	0,0	15,9	0,0	0,5	2,6	21,0	5,4	25,6	5,6	6,3	3,2	0,0
13	0,0	0,0	0,0	22,3	0,5	10,0	0,0	33,5	1,5	0,0	5,5	0,0
14	0,0	0,0	0,0	12,6	1,1	8,7	19,1	40,0	15,8	0,0	0,5	0,0
15	0,0	0,0	0,0	37,6	5,2	0,0	0,0	23,7	25,0	0,0	0,0	0,0
16	0,0	0,0	0,0	38,7	13,5	13,6	0,0	0,0	28,2	0,0	3,5	0,0
17	0,0	0,0	0,0	43,8	0,0	0,5	16,2	1,3	1,2	0,0	0,5	0,0
18	0,0	0,0	0,5	25,1	0,0	4,0	0,5	8,0	0,0	0,0	0,0	0,0
19	0,0	0,0	6,3	0,5	0,0	0,0	2,5	26,2	0,0	0,0	0,0	0,0
20	0,0	0,0	1,3	31,0	0,0	0,5	3,4	0,0	0,0	0,0	0,0	0,0
21	0,0	0,0	0,0	19,5	0,0	0,0	13,0	0,0	0,0	0,0	0,0	0,0
22	0,0	0,0	0,0	0,5	0,0	10,0	0,0	0,0	0,5	2,5	0,0	0,0
23	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,2	4,1	0,0	0,0
24	0,0	0,0	0,0	0,0	0,0	30,5	18,6	0,0	0,0	3,7	0,0	0,0
25	0,0	1,3	0,0	0,0	0,0	26,5	23,0	5,5	0,0	1,0	0,0	0,0
26	0,0	4,4	1,8	0,0	14,7	24,7	14,2	5,3	6,1	0,0	0,0	0,0
27	0,0	0,0	0,0	0,0	50,7	69,0	0,0	0,0	6,2	3,4	0,0	0,0
28	0,0	2,2	0,0	0,0	0,5	1,7	36,8	46,1	0,0	2,8	0,0	0,0
29	0,0		0,0	0,0	0,0	2,4	10,5	23,4	0,0	2,1	0,0	0,0
30	0,0		0,0	0,0	1,7	0,0	0,0	35,5	0,0	0,0	0,0	0,0
31	3,8		0,0		0,7		51,0	1,5		0,0		0,0

YEAR 2008 RAIN (mm/m^2)

DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	4,3	0,0	0,0	11,2	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
3	0,0	0,0	0,0	0,0	0,0	18,0	0,0	0,0	0,0	28,2	6,6	0,0
4	0,0	0,0	0,0	0,0	0,0	17,0	12,9	0,0	0,0	27,1	0,0	0,0
5	0,0	0,0	0,0	0,0	0,0	0,0	34,5	0,0	0,0	6,0	1,7	0,0
6	0,0	0,0	0,0	0,0	0,0	0,5	0,0	10,8	0,0	33,0	43,6	0,0
7	0,0	0,0	0,0	0,0	0,0	6,7	0,0	0,0	0,5	16,1	57,7	0,0
8	0,0	31,2	0,0	0,0	2,5	12,0	0,0	0,0	25,7	0,0	32,5	0,0
9	0,0	0,0	9,5	0,0	0,0	34,0	16,0	0,0	9,3	0,0	30,0	0,0
10	0,0	0,0	0,0	0,7	0,0	14,0	0,0	0,0	33,3	0,0	0,5	0,0
11	0,0	0,0	0,0	14,0	0,0	8,8	16,5	0,0	23,5	0,0	1,0	0,0
12	0,0	0,0	0,0	0,0	2,4	37,0	22,0	3,1	18,2	0,0	0,0	0,0
13	0,0	0,0	0,0	0,0	10,7	0,0	0,0	0,0	25,0	10,7	0,0	0,0
14	0,0	0,0	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,8	7,7	0,0
15	0,0	0,0	12,6	10,0	0,0	0,0	0,0	0,0	0,0	0,0	16,9	0,0
16	4,8	0,0	3,4	0,0	0,0	0,0	0,0	11,8	20,5	0,0	1,1	0,0
17	6,0	0,0	0,0	13,2	0,0	0,0	0,0	2,8	23,2	2,0	0,0	0,0
18	3,5	0,0	0,0	0,0	0,0	0,0	0,0	26,0	0,6	0,0	0,0	0,0
19	5,1	0,0	0,0	0,7	0,0	0,0	8,2	0,0	0,0	12,0	0,0	0,0
20	1,9	0,0	0,7	5,0	0,0	4,7	43,4	0,0	0,0	0,0	0,0	0,0
21	0,0	0,0	31,7	11,2	0,0	6,0	30,0	0,0	0,0	2,5	0,0	0,0
22	0,0	0,0	0,0	12,5	0,9	0,0	0,0	0,0	0,0	6,2	0,0	0,0
23	0,0	0,0	0,0	52,0	1,0	0,0	0,0	0,0	1,0	6,0	0,0	0,0
24	0,0	0,0	9,8	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
25	0,0	0,0	1,4	0,0	1,0	0,0	0,0	0,0	0,0	27,1	0,0	0,0
26	0,0	0,0	4,4	0,0	1,9	0,0	0,0	0,0	0,0	21,0	0,0	0,0
27	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,7	0,0	43,0	0,0	0,0
28	0,0	0,0	24,4	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,0	0,0
29	0,0	0,0	0,0	0,0	1,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
30	0,0		30,0	0,0	9,0	0,0	26,0	0,0	0,0	0,0	0,0	0,0
31	0,0		4,0		0,0		41,0	0,0		9,8		0,0

YEAR 2009 RAIN (mm/m^2)

DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,6	0,0	6,6	0,0	3,0	0,0	1,4	0,0	0,0
3	0,0	0,0	0,0	3,5	0,0	1,0	0,0	0,0	0,0	0,0	2,2	0,0
4	0,0	0,0	0,0	13,9	0,0	0,0	0,0	2,2	0,0	0,5	3,8	0,0
5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	11,5	0,7	0,0
6	0,0	0,0	0,0	3,2	0,0	0,0	0,0	0,0	0,0	0,0	2,5	0,0
7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
9	0,0	0,0	0,0	0,0	2,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
10	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
11	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
12	0,0	0,0	0,0	0,0	0,0	33,4	0,0	0,0	0,5	0,0	0,0	0,0
13	0,0	0,0	0,0	12,3	0,0	39,3	0,0	0,0	0,0	0,0	0,0	34,0
14	0,0	0,0	0,7	22,1	0,0	21,3	0,0	3,8	0,0	0,0	0,0	0,0
15	0,0	0,0	0,0	0,0	0,5	8,5	0,0	7,4	0,0	0,0	0,0	0,0
16	0,5	0,0	0,0	3,4	0,0	2,0	16,0	0,0	0,0	4,3	0,0	2,0
17	0,9	0,0	0,0	0,0	0,0	4,4	37,9	2,2	0,0	43,5	0,0	0,0
18	0,0	0,0	0,0	0,0	0,7	0,0	0,0	0,0	0,0	0,5	9,2	0,0
19	0,0	0,0	0,0	2,0	0,0	1,2	0,0	0,0	0,0	7,2	0,0	0,0
20	0,0	0,0	0,0	0,5	0,0	1,9	0,0	0,0	9,7	1,0	0,0	0,0
21	0,0	0,0	0,0	0,0	0,0	0,0	0,7	9,8	4,3	0,0	0,0	0,0
22	0,0	0,0	0,0	3,4	0,0	4,3	0,4	52,5	1,4	0,0	0,0	3,0
23	4,9	0,0	0,0	0,0	0,0	4,4	0,0	0,0	1,2	0,7	0,0	0,0
24	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,2	0,0	0,0	0,0
25	0,0	0,0	0,0	0,4	3,0	0,0	4,2	0,0	0,0	0,0	0,0	21,0
26	7,2	0,0	0,0	0,0	0,0	1,4	0,0	0,0	0,0	0,7	0,0	14,0
27	0,0	0,0	0,0	0,4	0,0	34,5	0,0	0,0	0,0	0,0	0,0	11,0
28	4,6	0,0	0,0	3,9	0,0	10,5	0,0	0,0	0,4	0,0	0,0	57,0
29	1,1		0,0	0,0	0,0	12,6	0,0	0,0	0,0	15,7	0,0	5,0
30	0,0		3,7	7,6	20,1	0,0	0,0	0,0	0,4	2,4	0,0	37,4
31	0,0		0,0		0,0		0,0	0,0		0,0		2,0

YEAR 2010 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	18,0	27,0	0,0	0,0	0,0	0,0	0,0	9,5	0,0
2	37,0	0,0	0,0	13,0	0,0	0,0	0,0	24,0	14,0	0,0	3,5	0,0
3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	26,5	0,0	0,0	0,0
4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
5	0,0	19,4	0,0	2,0	0,0	0,0	11,5	0,0	0,0	2,5	0,0	0,0
6	0,5	0,0	0,0	0,0	58,0	6,0	21,0	0,0	0,0	10,0	0,0	0,0
7	3,1	28,4	0,0	0,0	5,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
8	2,0	0,0	0,0	2,0	90,0	18,0	0,0	0,0	29,0	4,5	19,0	0,0
9	37,0	0,0	0,0	24,0	24,0	12,0	0,5	17,0	0,0	0,0	3,0	0,0
10	14,0	0,0	0,0	17,0	8,0	23,1	0,0	0,0	0,0	0,0	1,2	0,0
11	1,2	0,0	0,0	0,0	0,0	1,0	0,0	23,0	0,0	0,0	4,0	0,0
12	0,0	0,0	0,0	7,0	0,0	0,0	9,0	0,0	0,0	0,0	0,0	0,0
13	0,0	0,0	0,0	0,0	17,0	1,0	0,0	0,0	0,0	28,0	0,0	0,0
14	0,0	0,0	0,0	0,0	0,0	39,0	0,0	0,0	0,0	0,7	0,0	0,0
15	0,0	0,0	0,0	26,3	0,0	65,0	0,0	0,0	0,0	0,0	0,0	0,0
16	0,0	16,0	0,0	0,0	0,0	65,0	0,0	0,0	1,3	0,0	0,0	0,0
17	0,0	55,4	0,0	0,0	0,0	65,0	0,0	0,0	0,0	0,0	0,0	0,0
18	0,0	0,0	0,0	0,0	0,0	41,0	0,0	1,7	0,0	0,0	8,5	0,0
19	0,0	4,3	0,0	14,0	0,0	83,0	0,0	20,0	0,0	32,0	0,0	0,0
20	0,0	14,5	0,0	0,0	0,0	42,0	0,0	67,0	10,0	38,0	0,0	0,0
21	0,0	13,4	0,0	0,0	0,0	0,0	0,0	0,0	11,0	11,5	0,0	0,0
22	0,0	28,7	0,0	0,0	0,0	0,0	7,0	0,0	0,0	0,0	0,0	0,0
23	0,0	0,0	0,0	2,0	0,0	0,0	0,0	0,0	3,5	0,0	0,0	0,0
24	0,0	0,0	0,0	0,0	0,0	0,0	4,0	15,0	0,0	0,0	0,0	0,0
25	0,0	3,8	0,0	0,0	0,0	0,0	16,2	8,0	0,0	33,0	0,0	0,0
26	0,0	0,0	0,0	0,0	0,0	0,0	25,5	7,5	0,0	0,0	3,0	14,0
27	0,0	0,0	0,0	0,0	0,0	0,0	15,0	0,0	0,0	0,0	0,0	0,0
28	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,8
29	0,0		0,0	30,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
30	0,0		0,0	7,0	0,0	0,0	16,0	36,6	0,0	0,0	0,0	0,0
31	0,0		0,0		0,0		0,0	0,0		0,0		0,0

YEAR 2011 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	0,0	10,0	0,0	22,0	0,0	0,0	0,0
2	0,0	0,0	0,0	0,0	0,0	2,3	0,0	29,5	4,4	0,0	0,0	0,0
3	0,0	0,0	0,0	0,0	0,0	0,0	47,1	0,0	0,0	0,0	45,6	0,0
4	0,0	0,0	0,0	0,0	41,2	0,0	0,0	0,0	0,0	0,0	14,8	0,0
5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,7	0,0	0,0	20,0	0,0
6	0,0	0,0	0,0	0,0	6,4	0,0	0,0	0,0	74,0	1,5	10,0	0,0
7	0,0	0,0	0,0	0,0	0,0	0,0	9,0	0,0	16,0	0,0	18,0	0,0
8	0,0	0,0	0,0	0,0	0,0	0,0	54,0	0,0	15,0	0,0	0,0	0,0
9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	71,0	5,4	0,0	38,0	0,0
10	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,0	8,7	0,0
11	0,0	0,0	0,0	0,0	0,0	17,2	0,0	14,3	0,0	0,0	1,1	0,0
12	0,0	0,0	0,0	0,0	0,0	0,0	0,0	23,4	0,0	0,0	15,5	0,0
13	0,0	0,0	0,0	0,0	0,0	7,2	12,6	0,0	0,0	0,0	0,0	0,0
14	0,0	0,0	0,0	0,0	0,0	126,0	1,9	0,0	0,0	1,5	0,0	0,0
15	0,0	0,0	0,0	0,0	0,0	0,0	0,0	27,0	4,0	3,3	0,0	0,0
16	0,0	0,0	17,7	0,0	0,0	18,0	0,0	4,5	0,0	0,0	0,0	0,0
17	0,0	0,0	12,2	0,0	0,0	0,0	0,0	3,3	0,0	0,0	0,5	0,0
18	0,0	0,0	16,5	0,0	0,0	0,0	3,0	4,9	0,0	6,0	2,9	0,0
19	0,0	0,0	1,0	0,0	0,0	0,0	2,0	14,0	0,0	0,0	0,0	0,0
20	0,0	0,0	8,0	3,4	0,0	0,0	58,2	0,0	0,0	0,0	0,0	0,0
21	0,0	0,0	9,0	0,0	6,1	14,2	1,8	0,0	6,0	0,0	9,1	0,0
22	0,0	0,0	0,0	5,5	42,3	0,0	8,5	3,1	0,0	0,0	4,0	0,0
23	0,0	0,0	6,5	0,0	9,0	0,0	0,0	0,0	0,0	0,0	6,0	0,0
24	0,0	0,0	31,0	0,0	1,6	0,0	61,0	4,0	0,0	0,0	0,0	0,0
25	0,0	0,0	0,0	5,1	0,0	0,0	1,0	0,0	0,0	53,0	52,0	0,0
26	0,0	0,0	0,0	0,0	0,0	0,0	27,8	2,5	3,2	3,6	0,0	0,0
27	0,0	0,0	0,0	3,5	18,8	16,9	0,0	0,0	0,0	0,0	0,0	0,0
28	0,0	0,0	6,2	3,5	0,0	7,0	0,0	0,0	0,0	20,1	0,0	0,0
29	0,0		0,0	37,2	0,0	27,1	0,0	0,0	0,0	8,1	45,0	0,0
30	0,0		0,0	0,0	0,0	0,0	0,0	145,0	0,0	0,0	0,0	0,0
31	0,0		0,0		0,0		0,0	0,0		0,0		0,0

YEAR 2012 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	0,0	37,0	0,0	0,0	0,0	31,0	0,0
2	0,0	0,0	0,0	0,0	40,5	0,0	22,0	45,0	0,0	0,0	1,0	0,0
3		0,0	0,0	0,0	44,0	0,0	17,5	0,0	21,0	0,0	0,0	0,0
4	0,0	0,0	0,0	0,0	23,3	10,5	17,5	0,0	0,0	0,0	0,0	0,0
5	0,0	0,0	13,0	38,5	21,0	10,0	0,0	0,0	8,0	0,0	0,0	0,0
6	0,0	0,0	0,0	0,0	23,0	0,0	0,0	31,0	6,0	0,0	0,0	0,0
7	0,0	0,0	3,2	0,0	23,0	2,5	0,0	15,0	14,5	0,0	0,0	0,0
8	0,0	0,0	0,0	0,0	42,0	0,0	0,0	6,0	0,0	0,0	9,0	0,0
9	0,0	0,0	0,0	0,0	4,1	0,0	33,0	4,0	0,0	0,0	0,0	0,0
10	0,0	0,0	0,0	4,6	40,5	0,0	0,5	8,5	17,0	0,0	6,5	0,0
11	0,0	0,0	0,0	1,5	0,0	0,0	0,5	0,0	0,0	0,0	0,0	0,0
12	0,0	0,0	0,0	0,0	0,0	0,0	45,0	0,0	3,5	0,0	10,0	0,0
13	0,0	0,0	0,0	0,0	40,6	0,0	0,0	0,0	0,0	0,0	2,0	0,0
14	0,0	0,0	0,0	0,0	5,1	0,0	0,1	6,0	0,0	0,0	46,0	0,0
15	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0
16	0,0	0,0	0,0	20,2	0,0	13,0	30,2	21,0	0,0	0,0	0,0	0,0
17	0,0	0,0	0,0	10,8	0,1	0,0	7,5	0,0	0,0	0,0	0,0	2,0
18	0,0	0,0	0,0	2,5	34,0	0,0	4,2	0,0	0,0	0,0	10,5	8,0
19	0,0	0,0	0,0	31,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,4
20	0,0	0,5	0,0	3,2	0,0	5,5	0,0	60,0	0,0	0,0	0,0	0,0
21	0,0	0,0	0,0	0,0	11,3	5,5	0,0	5,7	0,0	0,0	0,0	0,0
22	0,0	0,0	0,0	30,0	0,0	3,0	0,0	0,0	0,0	0,0	0,0	0,0
23	0,0	0,0	0,0	31,7	3,4	0,0	23,0	0,0	0,0	0,0	0,0	6,0
24	0,0	0,0	0,0	51,0	0,0	0,0	60,5	0,0	0,0	0,0	0,0	6,5
25	0,0	0,0	0,0	33,0	16,3	0,0	0,0	0,0	0,0	0,0	1,0	0,0
26	0,0	0,0	0,0	19,4	0,0	43,8	36,1	0,0	0,0	0,0	0,0	20,0
27	0,0	0,0	0,0	65,6	0,0	0,0	0,0	0,9	0,0	32,0	0,0	33,0
28	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	31,0	0,0	3,8
29	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	11,0	5,5	15,5
30	0,0		0,0	72,5	0,0	0,0	87,5	0,0	0,0	2,0	0,0	12,5
31	0,0		0,0		0,0		11,5	0,0		0,5		12,0

YEAR 2013 RAIN (mm/m^2)												
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	5,6	0,0	40,0	18,0	27,0	0,0	5,0	70,5	0,0	0,0	0,0	0,0
2	0,0	0,0	0,0	13,0	0,0	0,0	5,0	0,0		0,0	0,0	0,0
3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	8,2	0,0	0,0	0,0	0,0
4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	11,8	0,0	0,0	0,0	0,0
5	0,0	0,0	0,0	2,0	0,0	0,0	0,0	7,1	0,0	0,0	2,6	0,0
6	0,0	0,0	0,0	0,0	58,0	6,0	0,0	13,3	0,0	0,0	0,0	0,0
7	0,0	0,0	0,0	0,0	5,0	0,0	0,0	2,0	0,0	0,0	0,0	2,0
8	0,0	0,0	0,0	2,0	90,0	18,0	0,0	0,0	0,0	0,0	8,1	0,0
9	0,0	0,0	0,0	24,0	24,0	12,0	16,0	0,0	0,0	0,0	0,0	0,0
10	0,0	0,0	0,0	17,0	8,0	23,1	22,0	2,3	0,0	0,0	0,0	0,0
11	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	17,2	0,0
12	0,0	0,0	0,0	7,0	0,0	0,0	45,0	0,0	0,0	0,0	26,0	0,0
13	0,0	0,0	0,0	0,0	17,0	1,0	45,0	12,0	0,0	0,0	2,5	2,1
14	0,0	0,0	0,0	0,0	0,0	39,0	45,0	8,0	0,0	0,0	14,0	4,2
15	0,0	0,0	0,0	26,3	0,0	65,0	0,0	34,0	0,0	0,0	6,0	4,0
16	7,2	0,0	0,0	0,0	0,0	65,0	10,0	5,5	0,0	0,0	0,0	5,3
17	1,8	0,0	0,0	0,0	0,0	65,0	30,0	12,0	0,0	0,0	0,0	9,3
18	0,0	0,0	7,0	0,0	0,0	41,0	0,0	12,0	0,0	0,0	11,6	0,0
19	0,0	7,0	13,0	14,0	0,0	83,0	0,0	12,0	0,0	0,0	15,5	0,0
20	0,0	13,0	19,0	0,0	0,0	42,0	0,0	4,5	0,0	0,0	0,0	0,0
21	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,0	0,0	0,0
22	0,0	6,0	6,0	0,0	0,0	0,0	10,0	0,0	0,0	0,0	0,0	0,0
23	0,0	0,0	0,0	2,0	0,0	0,0	25,0	4,0	0,0	0,0	0,0	0,0
24	0,0	5,0	2,0	0,0	0,0	0,0	28,0	11,3	0,0	0,0	0,0	0,0
25	0,0	2,0	0,0	0,0	0,0	0,0	12,8	11,3	0,0	0,0	0,5	0,0
26	0,0	10,0	5,0	0,0	0,0	0,0	18,1	11,3	0,0	0,0	0,0	0,0
27	0,0	0,0	10,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
28	0,0	45,0	0,0	0,0	0,0	0,0	12,0	0,0	0,0	0,0	0,0	0,0
29	0,0		0,0	30,0	0,0	0,0	12,0	6,5	0,0	0,0	0,0	0,0
30	0,0		45,0	7,0	0,0	0,0	13,0	0,0	0,0	0,0	0,0	0,0
31	16,0		0,0		0,0		51,0	0,0		0,0		0,0

	YEAR 2014 RAIN (mm/m^2)												YEAR 2015 RAIN (mm/m^2)											
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0
2	0,0	0,0	0,0	9,6	0,0	0,0	0,0	0,0	4,2	54,4	0,0	9,3	0,0	0,0	0,0	12,1	2,5	43,0	0,0	10,5	2,0	1,2	4,5	0,0
3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,2	11,2	0,0	0,0	0,0	0,0	0,0	12,4	0,0	0,5	0,0	4,5	22,4	0,0	27,2	0,0
4	0,0	0,0	0,0	2,5	0,0	0,0	0,0	0,0	3,6	0,0	6,0	0,0	0,0	0,0	0,0	5,4	19,3	0,0	0,0	0,0	22,4	0,0	0,0	0,0
5	0,0	0,0	0,0	0,0	0,0	3,3	0,0	3,4	36,3	0,0	0,0	0,0	0,0	0,0	0,0	8,1	0,0	49,0	0,0	0,0	0,0	0,0	0,0	0,0
6	0,0	0,0	0,0	0,0	0,0	1,3	0,0	6,2	0,0	0,0	6,9	0,0	0,0	0,0	0,0	0,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	17,5
7	0,0	1,0	0,0	0,0	0,0	0,0	0,0	14,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	39,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	17,5
8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	8,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	22,5	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
9	6,5	0,0	0,0	0,0	0,0	0,0	0,0	18,0	0,0	2,4	0,0	0,0	0,0	0,0	0,0	0,0	69,7	0,0	0,0	0,0	0,0	0,0	14,0	0,0
10	0,0	0,0	0,0	0,0	19,0	10,9	1,7	24,2	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	20,0	0,0
11	0,0	0,0	0,0	0,0	19,0	20,2	9,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	22,4	0,0	0,0	0,0	0,0	8,5	0,0	0,0
12	0,0	0,0	0,0	0,0	19,0	0,0	0,0	32,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	1,0	0,0	0,0	0,0	1,5	0,0	0,0
13	0,0	0,0	0,0	0,0	2,4	16,2	0,0	8,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	32,0	1,2	0,0	0,0	0,0	0,0	0,0	51,4
14	0,0	0,0	19,1	0,0	2,4	14,0	0,0	5,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,1	11,1	0,0	0,0	0,6	0,0	9,0	11,4
15	0,0	0,0	0,0	6,5	2,1	10,0	16,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,6	3,6
16	0,0	0,0	0,0	0,0	0,0	2,1	3,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	56,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
17	0,0	23,0	4,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,4	0,0	0,0	0,0	0,0	0,0	0,0	1,0
18	0,0	5,0	4,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	12,2	0,5	0,0	0,0	0,0	0,0	21,4	0,0
19	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	20,6	0,0	2,1	2,9	0,0	0,0	5,1	11,4	0,0
20	0,0	0,0	0,0	0,0	0,0	2,4	20,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0	0,8	0,0	0,0	18,4	0,0	0,0	2,5		0,0
21	0,0	6,2	0,0	0,0	0,0	19,6	26,0	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	3,5	0,0	0,0	2,0	0,0	0,0	0,0	0,0	0,0
22	0,0	0,0	0,0	0,0	0,6	19,6	38,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,2	0,0	2,5	14,0	0,0	0,0	0,0	0,0	0,0
23	0,0	0,0	0,0	0,0	0,0	19,6	12,2	3,0	0,0	2,5	0,0	0,0	0,0	0,0	3,9	2,8	0,5	4,1	14,0	0,0	0,0	4,5	4,2	0,0
24	0,0	0,0	0,0	0,0	0,0	0,0	8,0	3,0	0,0	1,5	1,5	0,0	0,0	0,0	0,0	1,8	0,0	0,0	19,0	0,0	0,0	0,0	0,0	0,0
25	0,0	0,0	12,6	0,0	0,0	0,0	15,3	3,3	0,0	0,0	26,5	0,0	0,0	0,0	0,0	7,1	4,2	0,0	19,0	0,0	0,0	0,6	0,0	0,0
26	0,0	5,4	2,6	0,0	0,0	0,0	55,0	25,5	0,5	0,0	0,0	0,0	0,0	0,0	0,0	2,6	0,9	0,0	19,0	0,0	0,0	2,6	18,4	0,0
27	0,0	0,0	0,0	0,0	0,0	0,0	38,0	7,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,6	0,0	0,0	42,0	0,0	0,0	37,7	3,3	0,0
28	0,0	0,0	0,0	0,0	0,0	0,0	23,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	32,4	0,0	0,0	1,5	0,0	0,0	0,0	0,0	0,0
29	0,0		0,0	0,0	0,0	0,0	0,0	12,2	0,0	0,0	0,0	0,0	0,0		0,0	0,5	0,0	0,0	1,5	0,0	0,0	0,0	0,0	0,4
30	0,0		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	22,5	0,0	0,0		0,0	20,5	5,1	0,0	1,5	0,0	0,0	1,3	0,0	0,0
31	0,0		0,0		5,3		0,0	0,0		0,0		0,0	0,0		0,0		2,4		10,5	1,0		24,5		0,0

	YEAR 2016 RAIN (mm/m^2)												YEAR 2017 RAIN (mm/m^2)											
DATE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,7	3,0	5,0	5,1	0,0	0,0	0,5
2	0,0	0,0	0,0	2,0	1,5	0,0	0,0	2,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	24,4	2,2	2,0	0,5	2,5	0,0	0,0	0,0
3	0,0	0,0	0,0	2,0	2,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	21,5	0,0	0,5	2,1	40,1	0,0	2,3	0,0
4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	15,5	0,7	2,1	0,0	0,0	0,0	0,0	0,0	0,0	8,2	0,0	41,2	0,6	8,0	0,0	17,1	0,0
5	0,0	0,0	0,0	91,0	0,0	3,3	0,0	16,5	0,0	0,5	0,0	0,0	0,0	0,0	0,5	0,0	3,1	0,0	53,7	0,0	35,0	0,0	44,0	0,0
6	0,0	0,0	0,0	0,0	17,5	1,3	0,0	9,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	13,7	0,0	0,6	0,0	9,5	0,0
7	0,0	0,0	0,0	0,0	38,0	0,0	0,0	2,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,0	0,0	0,0	17,0	0,0	0,0	14,5	1,0
8	0,0	0,0	0,0	0,0	23,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
9	0,0	0,0	7,5	0,0	9,8	0,0	0,0	10,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,8	0,0	0,0	14,1	0,0	0,0	0,0	0,0
10	0,0	0,0	37,7	0,0	1,1	10,9	1,7	6,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,6	0,0	0,0
11	1,8	0,0	0,0	0,0	3,8	20,2	9,1	0,5	0,0	0,0	0,0	0,0	1,8	0,0	0,0	0,0	0,0	0,0	24,7	40,5	0,0	7,2	0,0	0,0
12	0,0	0,0	0,0	0,0	3,5	0,0	0,0	2,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,0	0,0	6,8	22,1	2,8	0,0
13	0,0	0,0	0,0	0,0	14,5	16,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,1	0,0	14,1	7,1	16,4	0,0
14	0,0	0,0	0,0	0,0	0,0	14,0	0,0	4,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,5	13,0	0,0	7,8	3,0	0,0
15	0,0	0,0	0,0	0,0	3,5	10,0	16,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	39,2	0,0	7,2	1,1	2,3	0,0
16	0,0	0,0	0,0	0,0	4,0	2,1	3,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,5	0,0	0,0	3,0	0,6	0,0	0,0
17	1,5	0,0	0,0	15,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,5	0,0	0,0	0,0	0,5	0,0	8,0	0,0	10,1	9,5	0,0	0,0
18	1,7	0,0	0,0	5,0	10,5	0,0	0,0	0,0	0,0	2,6	0,0	0,0	17,0	0,0	0,0	0,0	4,8	0,0	1,8	0,0	2,1	10,0	0,0	0,0
19	0,0	0,0	5,5	2,0	2,9	0,0	0,0	0,0	0,0	1,7	0,0	0,0	4,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,2	30,0	0,0	0,0
20	0,0	0,0	0,0	0,0	9,5	2,4	20,0	0,0	0,0	0,7	0,0	0,0	0,6	0,0	0,0	33,2	0,0	0,0	0,5	0,0	0,0	34,0	0,0	0,0
21	0,0	0,0	0,0	0,0	0,0	19,6	26,0	0,0	6,6	0,0	0,0	0,0	0,0	0,0	0,0	3,0	4,0	7,5	7,6	0,0	0,0	30,5	0,0	0,0
22	0,0	0,0	0,0	0,0	6,5	19,6	38,2	1,2	44,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	1,8	4,8	0,0	6,3	25,4	0,0	0,0
23	0,0	0,0	0,0	0,0	0,0	19,6	12,2	2,7	0,0	34,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,2	13,8	11,0	30,5	0,0	0,0
24	0,0	0,0	0,0	0,0	0,0	0,0	8,0	0,0	0,0	4,5	0,5	0,0	0,0	0,0	27,5	0,0	0,0	0,0	22,2	16,7	0,6	36,5	0,0	0,0
25	0,0	0,0	0,0	0,0	0,0	0,0	15,3	1,2	0,0	0,6	0,8	3,3	0,0	0,0	4,2	0,0	0,0	0,0	22,3	13,2	3,6	20,1	0,0	0,0
26	0,0	0,0	0,0	0,0	0,0	0,0	55,0	0,0	0,0	2,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	22,3	11,1	0,0	5,2	10,6	0,0
27	0,0	0,0	0,0	30,0	0,0	0,0	38,0	0,0	25,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	22,1	0,0	27,0	0,0	0,0	14,6	0,0	0,0
28	0,0	0,0	0,0	62,0	0,0	0,0	23,0	0,0	18,2	0,0	0,0	0,0	0,0	8,3	4,2	0,0	23,2	0,0	2,0	0,0	0,0	30,6	0,0	0,0
29	0,0	0,0	0,0	36,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		2,1	0,0	10,0	0,0	11,0	10,0	0,0	3,0	0,0	0,0
30	0,0		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0	0,0	28,0	0,6	12,8	6,6	0,0	0,0	0,0	0,0
31	0,0		0,0		0,0		0,0	0,0		0,0		0,0	0,0		0,0		19,5		2,8	21,7		0,5		0,0

Table 12: Rain data obtained from the local authorities of Kabarnet


BAMBA FAMILY